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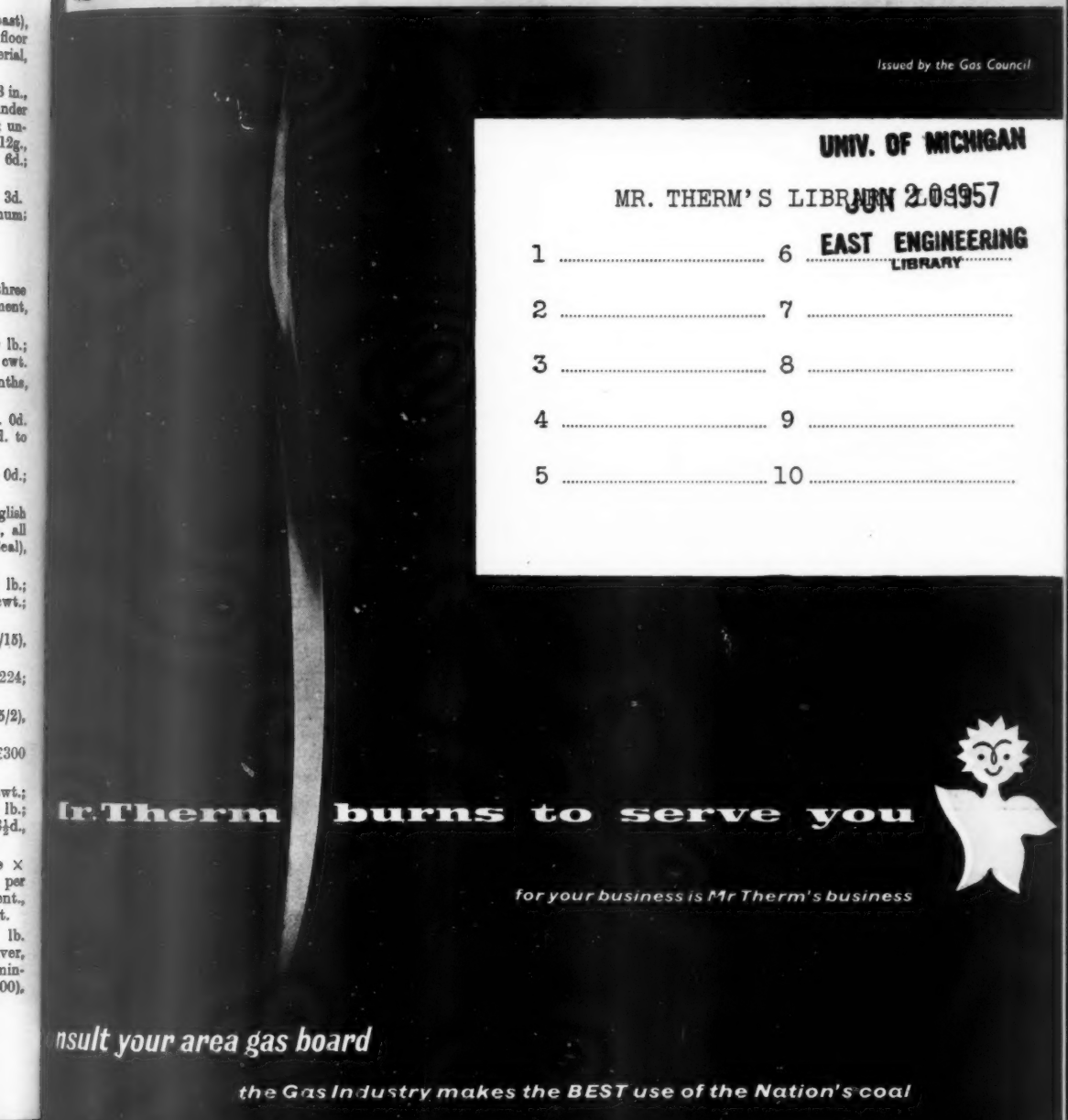
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Founding in Denmark

There are only about 100 foundries in Denmark and as in the other Scandinavian countries, many of these are quite small. The output of grey-iron castings is about 125,000 tons annually. The economy of the industry seems likely to follow closely that of this country, as, unlike Norway and Sweden, the country has no hydro-electric power-stations and has to rely on solid and liquid fuels. It has good natural resources for moulding sand, but relies on Germany for coal and coke supplies. Of foundry pig-iron, some is made locally as a by-product of cement making, but most is imported from Holland and Germany. There are only two steelfoundries in the country, one in Copenhagen and one in Aartius. The latter was started up during the 1914 war and is now changing over from the Tropenas Process to electric melting. Generally speaking, the foundries operate their own patternshops, but there are a few master patternmakers, one of whom makes metal patterns.

Technically, the Danish foundry industry is catered for by the mechanical-engineering department of the Royal Technical College. Here, there is a special section under the direction of Professor Ove Hoff which offers a complete practical and theoretical training for foundry students. It is staffed by a foundry technologist, a foreman, two moulders, a coremaker and a labourer and is used by that percentage of the mechanical engineering students wishing to include foundry technology in their training. Graduates of the College readily find employment not only in Denmark, but in Sweden and America. There is reported to be no shortage of foundry apprentices in Denmark. Quite a quantity of gas cookers and stoves are used in Denmark, but in the villages, where no town's gas is available, an increasing demand is shown for apparatus burning propane, Calor gas and the like. We were told that liquid fuel was popular, but whether this meant fuel oil or a liquified and bottled gas we were unable to determine.

Second, perhaps to Holland, the people of Denmark are enormous users of bicycles and provision is made for their parking everywhere. In general the models are more utilitarian than luxurious, but those parked in the streets on the occasion of the firework display from the Royal yacht on the occasion of Her Majesty's visit certainly entered the latter class. This gave rise to the thought that many citizens must possess two—one for business and one for high days and holidays and here, possibly, lies a market for British makers. Finally, we advise British manufacturers of goods for this, or indeed any market, to label their productions "designed by . . ."—the name does not matter much, but the implied snob appeal certainly enhances sales.

Luncheon

FOUNDRY COKE MERCHANTS' ASSOCIATION

Last Thursday, the annual luncheon of the Foundry Coke Merchants' Association, at the Waldorf Hotel, London, was attended by about 50 members. Mr. E. Tasker (Darby & Company (B'ham), Limited) presided, and after the "Loyal Toast" it was he who proposed that of "The Guests." Mr. Leslie O'Connor, C.B.E., director of the British Coking Industry Association, graciously responded. He mentioned the satisfaction he and his colleagues had in negotiating with the coke merchants as a single body. His somewhat enigmatic statement that future production plans of the NCB appear to be in line with forthcoming demands for foundry coke, was tempered with the news that an attempt may be made to introduce quality incentives to producers. Other speakers included Mr. W. Armstrong (Durham Division, NCB) and Mr. C. F. Sullivan (South Western Division, NCB).

At the annual meeting which followed the luncheon, Mr. Tasker was re-elected as chairman of the Association, with Mr. R. J. McDonald (McDonald, Muter & Company, Limited) as his deputy. Retiring committee members, representing J. C. Abbott & Company, Limited, Darby & Company (B'ham), Limited, and Chas. B. Pugh, Walsall, Limited, were re-elected, as was Mr. S. Owen, secretary and treasurer. A feature of the afternoon's proceedings was a presentation of an electric coffee percolator to Mr. R. B. Hearne, as a tribute for his work in organizing the Association's annual dinner.

Expanding Bulawayo Foundry

A report of expanding foundry facilities has been received from All Metal Founders (Pvt.), Limited, a concern started by the managing director, Mr. B. Kremer, in 1949. To-day there is a payroll of approximately 80 natives, three Europeans and a mixed production of about 15 tons of castings weekly. These are mainly of iron—stoves, municipal castings, pipes, etc.—but there is a fair amount of copper-base and some light-alloy. Melting facilities include a pair of cupolas and a number of crucible furnaces; moulds for repetitive items are produced on moulding machines. The covered area is about 30,000 sq. ft. and the castings up to 10-cwt. are catered for. A project which may interest JOURNAL readers is that the Bulawayo concern is seeking arrangements to manufacture UK foundry specialities for the Federation of Rhodesia and Nyasaland and possibly, also, for South Africa, under licence, or on a royalty basis. Anyone interested in following up this idea should write direct (P.O. Box 1232, Bulawayo, S.R.).

Latest Foundry Statistics

From figures issued by the British Bureau of Non-Ferrous Metal Statistics it is learnt that the output of copper-base castings during March was 6,511 tons. The three-month total of 20,036 tons shows a decrease of 248 tons compared with the corresponding period for 1956. The current production rate of pure copper castings is 650 tons monthly.

According to the *Bulletin* of the Iron and Steel Board and the British Iron and Steel Federation, employment in the steelfoundry industry on March 9, was 20,660. This shows an increase of 30 on the figure for February 9, and of 410 on that for March 1956. The average weekly production of steel castings is given provisionally as 5,800 tons. In February it was estimated to be 7,100 tons and in March 1956, 6,300 tons.

Materials Testing Mission to visit USA

A mission to study materials testing in the engineering and electrical industries in the United States is being organized by the European Productivity Agency. Particular attention will be paid to non-destructive testing methods but testing to destruction will also be studied. Although the main concentration will be on ferrous and non-ferrous metals, it is hoped that there will be opportunities for studying the testing of plastic materials or chemical products.

The programme in the United States is scheduled to last five weeks starting at the beginning of October, so as to enable those who wish to do so to take part in the second World Metallurgical Congress to be held in Chicago from November 2 to 8. The mission is to be limited to 30 persons and should include experts on laboratory tests and research, and experts on the practical application of tests in industry and manufacturers of testing equipment; it is to be self-financed, members being responsible for their travelling expenses and the cost of their stay in the USA. Applications to participate should be submitted to EPA by June 8, addressed to Engineering Industries Division, (Branch E.I.D.1(a), Board of Trade, Horse Guards Avenue, S.W.1. (Telephone TRAfalgar 8855, Extension 7507).

RSA Awards

The Council of the Royal Society of Arts, Adelphi, London, W.C.2, announce the following awards in the domestic electrical appliance and domestic solid-fuel-burning appliance sections of the 1956 Industrial Art Burseries competition. In the former section, Mr. D. L. Morgan, age 17, of the Kingston School of Art, has received a bursary to the value of £150, and Mr. G. T. Church (Birmingham College of Arts and Crafts) and Mr. A. R. Copp (LCC Central School of Arts and Crafts) are commended. In the domestic solid-fuel-burning appliance section, Mr. D. J. Keepax, age 19, of the Birmingham College of Arts and Crafts, is the recipient of a £150 bursary, and Mr. J. D. Payne, also a student at the Birmingham College of Arts and Crafts, is commended. The bursaries will be used for travelling abroad and gaining knowledge and experience of foreign design at first hand.

British Oxygen's New Works

Due to the rapid expansion of industries in the north-east, British Oxygen Gases, Limited, is building a new factory at Grangetown, Middlesbrough, at an estimated cost of £1,750,000. The new plant, built by British Oxygen Engineering, Limited, will produce compressed and liquid oxygen, and liquid and tonnage nitrogen (which will be fed, after purification, by pipeline to the ICI factory at Wilton). A plant capable of producing 200 tons of gaseous oxygen per day will also come into operation at a later date. Other industrial gases manufactured by the company will also be distributed from Grangetown. The activities of the British Oxygen factory at Billingham have been transferred to the new site, which comprises 20 acres.

THE EXHIBITION OF COLOUR PHOTOGRAPHS by Mr. Adolph Morath, which was held recently at the Tea Centre in London, will be staged in Liverpool from June 7 to 14 at the Liverpool College of Art. The exhibition will be open daily from 10 a.m. to 5 p.m.

Creep-resisting Steel Castings for Use at Medium and High Temperatures*

By H. Zeuner

Higher stresses and strains are now imposed upon steel castings used in engineering and aircraft constructions, as a result of the higher operational speeds and temperatures required by these rapidly developing industries. The investigation and correlation of characteristic material data and safety factors for the calculation of wall thicknesses of castings is therefore assuming major importance, for both the designer and the founder. The application of these data together with the creep-resisting properties of steel castings are dealt with in this Paper. The Author concludes with details and effects of the various heat treatments that may be utilized to enhance the mechanical properties of certain steels.

The increasing use and more stringent requirements for cast steels with good strength at elevated temperatures make it necessary that designers, and founders, should be fully acquainted with the typical casting alloys and their respective properties under prolonged applied stresses. The correct application of the safety factors as well as the interpretation of the results of long-time creep studies—which are being established by specific investigation methods for the appropriate temperature levels—is frequently of decisive importance in calculations for cast parts.

Application of Data

There is little doubt that the equations used for the calculation of cast-steel pipes (DIN No. 2412) and rolled-steel tubes (DIN 2413) are the most interesting points of the various leaflets issued by the German Pressure Vessel Association and the German Boiler and Pressure Vessel Committee (DDA) for the calculation of the wall thickness of pressure vessels.

Wall-thickness Calculation

Foundry metallurgists and casting designers will also be interested in the material data and safety factors mentioned[1, 2]. For working temperatures up to 400 deg. C. the 0.2 per cent. hot yield-point can be used as a basis for calculation, the Boppard Committee of the DDA (a sub-committee of the German Boiler and Pressure Vessel committee), however, expressed an opinion in December 1953, deciding against the application of the DVM—creep limit (DVM—*Deutscher Verband für Materialprüfung* [German Society for the Testing of Materials]) in the temperature range of 400 to 525 deg. C. Instead it recommended the use of "long-time" values for the calculation of boiler plant and turbine-set. Due to the absence of precise data in the standard specifications for high-temperature steel castings there is often no alternative to the continued use of DVM-values.

Many omissions are already being rectified by the research programme of the German Iron and Steel Association, by investigations made by steel foundries and their customers, and by an intensive search of the published literature. Material experts of the steel foundries as well as those of the rolling mills and forging plants hold the view that the DVM short-time tests, establishing the speed of elongation between the 25th and 35th hour, cannot give any information on the long-time behaviour of a material, as changes of structure occurring in the range of working temperature, and hot embrittlement cannot be established during long annealing periods. Assent is therefore given to the request for long-time data based on about 20,000 to 60,000 experimental hours and extrapolation of the results to 100,000 hr. at temperatures up to about 750 deg. C.

Gas-turbine Components

For applied stresses in gas- and hot-air turbine manufacture no extrapolation beyond 10,000 hr. is practically necessary, if the actual experiments are carried out over a period of 300 to 5,000 hr. This is because such plants are, in many cases, only designed for a relatively short life (*e.g.* ship- and aircraft turbines) or they are so lightly stressed, mechanically, that only resistance to scaling and corrosion are of decisive importance (*e.g.* fuel industry). This is valid in so far as such parts have not to be replaced by special "super" alloys which in consequence of their high price have to prove their economy in stationary plants by their longer life.

Furnace Components

This problem presents itself in a slightly different way in two respects for furnace parts, because such constructions must aim at a very long period of usefulness, and because the working temperature can, in many cases, be as high as 1,500 deg. C. For applications of the materials in the temperature range of 700 to 900 deg. C., the long-time creep properties cannot be examined for a sufficient period of time to obtain a far-reaching survey of the possibilities of embrittlement by the segregation of carbides, nitrides and the sigma phase. For working temperatures from 900 to 1,150 deg. C., tests over a period of 1,000 to 5,000 hr. are sufficient in the first instance to ascertain the long-time creep behaviour; as in this temperature range, the austenitic structure with its solubility for carbides and nitrides and their scattered segregation are responsible for the

* Communication from the Bergische Stahlindustrie, Remscheid. Abstracted by Dr. O. P. Einerl from a paper presented at the International Foundry Congress in Düsseldorf.

long-term behaviour. Such " quasi-short-time tests " are justified because of the relatively good conditions for diffusion, and in most cases conditions of equilibrium will occur with certainty in the high-temperature range.

Safety Factor

The assessment of the safety factor " S " is of critical importance in cast-steel parts for application, under pressure, in the manufacture of boilers and turbines, for use up to about 700 deg. C. and for non-corrosive uses in fuel synthesis plants up to 560, also for furnace parts above 750 deg. C.

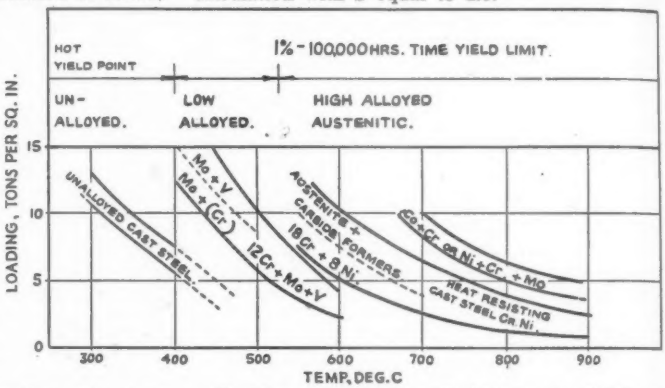

FIG. 1.—*Comparison of creep-resisting steels with varying temperature.*

The safety factor is less important for materials in oil refineries with corrosive attack in the temperature range up to 700 deg. C. In this case the wall thickness calculation will mainly provide such large corrosion allowances that the cross sections of the casting can cope with a multiple of expected attack without reaching the long-time values laid down in the equations for the calculation. If, within the working-temperature range, hot embrittlement occurs, which may be caused by the segregation of dispersals of carbides or, in the case of austenitic materials, by the segregation of inter-metallic compounds, one must not underrate their frequent effect of increasing the long-term creep resistance in relation to the assessment of the safety factor " S," despite the disagreeably low toughness values at room temperature. As will be shown later, a certain superiority expresses itself, in this way, for the high heat-resisting and creep-resisting materials, as compared with rolled stock or forgings of the same composition. Summarizing the foregoing consideration, it is recommended to make use, or to take notice of, the following data for the varying temperature ranges and for differing uses:

(*a*) Castings Subjected to an Inner Pressure by Steam or Liquids up to a Working Temperature of 700 deg. C.

Within a working-temperature range of 120 to 400 deg. C. the 0.2 per cent. hot-proof stress can be used as material data for pressure-bodies, fittings, turbine casings and pipe parts. The safety factor S should be 2.0 up to a working-temperature of 350 deg. C., beyond this and up to 400 deg. C. it is recommended that the factor S be 2.5. Beyond 400 deg. C. the long-time data have to be used for calculations. Generally, the time-yield limit YP.1/100,000 can be used without safety adjustment (S = 1.0). If no experimental data are available for YP.1/100,000 values, it is permissible to use ultimate tensile/100,000 taking the factor S between 1.5 and 2.0 according to the material. As an example, materials with flat curve graphs for tertiary creep, should be regarded as requiring a higher factor based on ultimate tensile/100,000. If only DVM-creep-limit values between 350 and 450 deg. C. are available, they can be used for a calculation with S equal to 2.0.

Turbine-casings with wall thicknesses of 3 in., or more, are exceptions and are always calculated with ultimate tensile/100,000 and a safety factor of 1.5. It is, however, left to the experience of the designer to avoid adverse influence on the running properties of the turbine by keeping the stress of the casting as low as possible.

If corrosive action in pipes, *e.g.* by high sulphur and chloride containing oils, has to be expected, the calculated-minimum wall thickness must be increased by $\frac{1}{8}$ to $\frac{1}{4}$ in., furthermore an allowance can be added in order to counter possible erosion of the material if a change of direction of the flowing medium has to be expected. When calculating the wall thickness of parts, which will work mainly in the high-pressure field, care has to be taken that water-pressure tests carried out at the required pressure should be within a safety factor of 1.1 against the yield-point at room temperature.

(*b*) Gas- and Hot-air Turbines with Low Working Life Above 600 deg. C.

That it has been possible to lay down general instructions for the wall thickness with allowances and coefficient of safety, *etc.*, in the manufacture of boilers and turbines, can be explained mainly by the fact that the state of stress in most of their components can be clearly established. There are so many differently stressed components in the manufacture of gas- and hot-air turbines that it is hardly possible to lay down standard methods for their calculation using exact safety factors. As all the materials used for load-carrying parts in gas turbines still are, for the time being, alloys

with a certain capacity for plastic deformation, a basis for multiaxial conditions of stress that can be taken in the reduced stress which results from the deformation-energy hypothesis, and this figure can be compared with the established tensile strength for the monoaxial condition of stress. The request for the utmost weight reduction compels, for instance, the designer of aero turbines, to utilize the time-dependency of the material properties to the limit, coupled with the lowest coefficients of safety. The subsequent thin section enforces the requirement that the influence of the surface condition and dimensional tolerances on the safety factor, must be kept as small as possible.

Generally speaking, the components of gas turbines could be arranged into three groups, as follows: (1) components which have to stand up to a predominantly permanent stress; (2) components

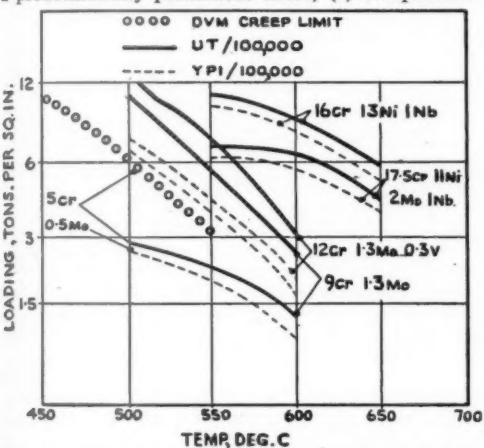

FIG. 2.—*Effect of increasing chromium content in cast steel compared with heat-resisting austenitic materials.*

which require stability of shape; that is to say they must not be liable to suffer from distortion to any appreciable degree, and (3) components which are subjected to a continually changing stress.

Even if the components mentioned under (1) and (2) are, correctly speaking, under changing stresses caused by vibrations which are not wholly unavoidable, one has to use the long-time creep-resistance values established during distinct periods as limit-values for the calculation. It is customary to calculate for reduction gears with ultimate tensile/100, for aero-gas-turbines for military purposes probably with U.T./300 or U.T./800; for those required for non-military purposes; U.T./1,000 or U.T./2,000 for marine gas-turbines with U.T./5,000 or U.T./10,000. The customary coefficients of safety vary between 1.2 and 2.2 in accordance with type of component, material, method of production and correctness of stress calculation. Larger safety factors have to be applied for cast components, the mechanical

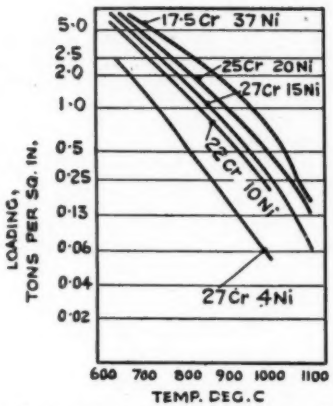

FIG. 3.—*Effect of temperature on the time-yield limit, for a permanent deformation of* 1.0 *per cent., after* 10,000 *hr., for heat-resisting and high-temperature steel castings.*

properties of which cannot be tested when finally machined. If the material properties "as-cast" are known to be comparable with the mechanical properties obtainable in the wrought form, the coefficient of safety for the design of castings can be chosen between 1.1 and 1.3. The construction of the component must, however, be as rigid as possible as distortion would result in a decrease of efficiency and possibly mechanical damage by loss of clearance. For such calculations it is essential to know the stress for 0.2 per cent. permanent deformation after 1,000 hr. testing. Turbine blades and sheaves are exposed to stresses which vary along the radius, they also have changes of section such as notches, drilled holes, etc., with resultant localized peak stresses. Finally the yield point or the long-time creep-resistance values can be exceeded without danger, if one assumes that the short- and long-time elastic-limits are higher for uneven stress distribution than for a uniformly-applied tensile-stress.

The components of the third group, such as shafting, gear-wheels, bolts, etc., are usually made from rolled and forged materials. Calculations in these cases are generally based on safety factors of not less than 2, usually about 2.5, on account of unrevealed surface-defects and the unreliability of known vibration-stresses.

(*c*) Furnace Components Subjected to Tensile Stress Above 700 deg. C.

The figures to be used for the calculation in these cases are either yield point 1/100,000 with S=1.0 or ultimate tensile/100,000 with S of 1.3. It is permissible for easily exchangeable parts (for which very large wall thicknesses should be avoided), to calculate with a time-yield limit of yield point 1/10,000 (S=1.5). From these data it is then possible, in many cases, to predict the presumable .working life. For very highly-stressed

parts, where, for instance, the stress cannot be defined as merely tensile, it is necessary, on account of the wall-thickness tolerances and a certain scatter of material properties, to check the actual dimensional changes taking place at intervals of about 500 working hours, by measuring the distance between two location marks. It is then possible to predict, approximately, the expected life from the dimensional changes that occur. Generally it can be stated that it is not customary to make a special wall-thickness allowance on account of scaling losses.

Typical Casting Materials at Medium or High Temperature Ranges

A survey of the heat-resisting casting alloys by K. Roesch[3] is given in Fig. 1. This gives an impression of the long time behaviour of commercially obtainable materials at higher temperatures. The chemical compositions are approximately as follows:

Group 1 (unalloyed-steel castings) C 0.2 to 0.25; Si, 0.3 to 0.5; Mn 0.5 to 7; Cr max. 0.3 per cent.

Group 2 (low-alloy steel castings) C 0.2 to 0.25; Si 0.3 to 0.5; Mn up to 1.0; Cr up to 9.0; Mo 0.4 to 1.4; and V 0.2 to 5 per cent.

Group 3 (medium-alloy steel castings) C 0.05 to 0.1; Si 0.3 to 0.5; Mn 0.3 to 0.5; Cr 16.0 to 18.0; Ni, Ti,Ta and Nb 10.0 to 13.0 per cent.

Group 4 (high-alloy steel castings) C, 0.25 to 0.4; Si 1.0 to 2.0; Mn 0.5 to 1.5; Cr 21.0 to 28.0; Ni 4.0 to 38.0 per cent.

As can be seen from Fig. 1, the addition of small quantities of molybdenum (0.4 per cent.) increases the creep-resistance of unalloyed or low-alloyed steel castings considerably; this can be attributed to the higher recrystallization temperature and the segregation of molybdenum carbide (Mo_2C) which is difficult to coalesce. The dispersal of the carbides (consisting of the compounds of carbon with Mo, V, Ti, Ta/Nb or Cr) largely prevents the formation of slip planes at the grain boundaries.

The low-alloyed steel castings with up to 0.3 per cent. Cr, which are distinguished by a good weldability, acquire better heat resistance by the addition of molybdenum and vanadium; the long-time creep properties improve when the molybdenum content is increased from 0.4 to 0.7 per cent. and the vanadium content from 0.2 to 0.45 per cent. simultaneously.

The alloys of this group will satisfy all requirements up to working-temperatures of about 500 deg. C. At 550 deg. C., their long-time values after 100,000 hr. become of no importance as factors for the design of heat-resisting components. A further increase of molybdenum plus vanadium to 0.85 per cent., coupled with a chromium-content of 1.0 to 1.5 per cent., can achieve a suitable long-term heat-resistance, however, the alloys are not resistant to scaling above 540 deg. C.

In order to produce a material suitable for turbine casings (working at 540 deg. C.) which could

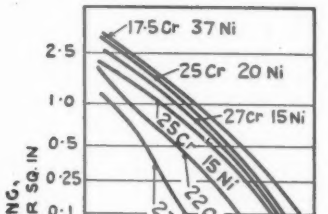

FIG. 4.—*Effect of temperature on the time/yield limit for a permanent deformation of* 1.0 *per cent., after* 100,000 *hr., for heat-resisting and high-temperature steel castings.*

stand up to further slight temperature increases, offering at the same time a certain resistance against scaling, it is necessary to increase the chromium content to 2.25 per cent. and the molybdenum to 1.0 per cent. The less satisfactory long-term properties can be balanced by providing a second (outer) casing which naturally will be less stressed on the heated side, and in addition can absorb a certain amount of the heat transfer. For applications up to 540 deg. C. working temperature, a steel casting with Cr, 1.25; Mo, 1.0, and V, 0.5 per cent. will give the best creep-resisting properties with about 8 tons per sq. in. after 100,000 hours.

To overcome the temperature threshold of 525 to 550 deg. C. it is necessary to add more chromium to the steel castings, molybdenum and vanadium being present together, up to 1.5 per cent. The long-time values will be only slightly increased and scale resistance has to be obtained at the expense of reducing these values. Typical examples are the investigations on alloys which are resistant to hydrogen under pressure and are being used in oil-refining industries. These alloys contain 2.25. 5.0 and 9.0 per cent. chromium respectively. Only after further increase of the chromium content to at least 11.0 per cent., will the long-time values become so good that such steels can be used at temperatures between 525 and 550 deg. C.

Some years ago an alloy with 12 per cent. chromium; 1.3 molybdenum and 0.3 vanadium was introduced successfully for engine production. This alloy must be so balanced in regard to its carbon- and silicon-content that the microstructure is free from delta ferrite. With this pearlitic casting material the use of "ferritic steel castings" has been extended to working temperatures up to 600 deg. C.

Fig. 2 shows the improvements possible with increasing chromium content compared with heat-resisting austenitic materials. E. Houdremont[4] explains this fact by expressing his view that the cubic face-centred lattice of the austenitic iron possesses a better heat resistance compared with the cubic body-centred lattice of the ferritic iron; this is due to its stronger resistance to atomic migration. Independent from intermediary phases presenting themselves in certain circumstances, it can be concluded, from the theory of resistance to migration, with tighter spherical packing, that it is not possible to develop creep-resisting alloys based on iron without the introduction of austenite-forming elements.

The austenitic heat-resisting steel specifications of the 18/8 chromium/nickel type and its variations to the stable-austenitic material containing 16.5, Cr, 13 per cent. Ni and additions of Ta and Nb, are suitable for the requirements of the engineering industry up to working temperatures of about 750 deg. C. and especially suitable for the prevention of inter-crystalline corrosion in steam carrying parts when stabilized with Ta/Nb. They also form the basis for the development of castable super-

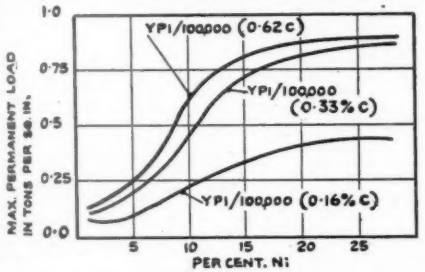

FIG. 5.—*Influence of carbon and increasing nickel content on the maximum-permanent load of heat-resisting Cr/Ni castings with 25 per cent. Cr at 1,000 deg. C.*

alloys for the production of short-life aero-turbine parts. The present availability of materials with high creep-resistance in the temperature range up to 900 deg. C. mainly comprises forging alloys which often only obtain their extraordinary load-carrying capacity after complicated heat-treatment and hot-cold working. Typical casting alloys for this range of temperatures only exists to-day in isolated cases; extensive systematic development work will have to be effected by the foundries-material experts in order to offer marketable materials, the properties of which equal the forging alloys. It seems obvious that iron as the basic element will have to be abandoned and replaced by nickel or similar elements, investigations on this matter have already begun but progress reports must be left to a later date.

Figs. 3 and 4 show the course of the time-yield limit for a permanent deformation of 1.0 per cent. after 10,000 and 100,000 hr. respectively, for heat-resisting and high-temperature steel castings in relation to the temperature. After achieving resistance to scaling (up to temperatures of about 1,150 deg. C.) by addition of approximately 25 per cent. chromium, the high-temperature strength increases rapidly with increased nickel content up to the stable-austenitic condition, but only very slowly after that.

Of special importance and characteristic for the cast heat-resisting Cr/Ni steels is the carbon content of about 0.3 per cent. This carbon dissolves in the austenite at high temperatures and increases the hot-strength; in addition the complex chromium carbides prevent the formation of slip planes at the grain boundaries and within the crystallites, and contribute in this way to the increasing creep-resistance. On the other hand, the higher carbon content of 0.3 per cent. causes a greater brittleness in comparison with a carbon of 0.1 per cent. which is the usual content for 18/8 austenitic steels.

Fig. 5 clearly demonstrates the influence of nickel and carbon at 1,000 deg. C. The values given are the results of long-time tests with cast chrome-nickel steels containing varying amounts of carbon.

Fig. 6 illustrates the experimental results obtained by G. T. Colegate[5], comparing the time-yield limits of low carbon (0.06 per cent.) 18/8 chrome/nickel steels with high carbon (0.30 per cent.) high chromium and nickel containing heat-resisting cast-steels. The author was able to confirm these figures by his own experiments and extrapolated values.

Cast steels with 27 per cent. chromium and 4 per cent. nickel suffer from dangerous hot-brittleness in the temperature range from 650 to 900 deg. C. as a result of sigma-phase formation (Fe/Cr) and should therefore only be used for working temperatures exceeding 900 deg. C. Cast steels with 25 per cent. chromium and 5 per cent. nickel as well as those with 27 per cent. chromium and 15 per cent. nickel show, in their micrographic structure, traces of delta ferrite—an indication of a sigma phase transformation—however, in these cases there is only a slight increase of brittleness, for the as-cast structure is very stable.

The well tried 25/20, and 16/36 per cent. chrome/nickel cast steels are well suited for uses in the high-temperature range, even if their long-time values at 1,100 deg. C. are small in comparison with those of the ferritic cast steels.

Heat Treatment

Annealing with hardening and tempering is necessary for all these steel casting alloys with the exception of the unalloyed and the heat-resisting high-temperature Cr/Ni alloys. The effect of molybdenum and vanadium as additions to ferritic materials in order to increase their creep-resistant properties is attributable to the segregation of these elements as carbides within the grain boundaries. The high yield point of hard annealed steels at normal temperatures results, in the first 10,000 hr. of long-time tests, a considerable increase of the elongation and strength values, but thorough investigations indicate that such over-treated steels, after initially good properties, show a sharp decline of their strength in the course of time. The decline

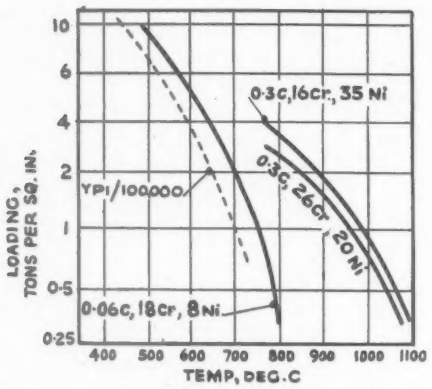

FIG. 6.—*Experimental results obtained by G. T. Colegate[5], comparing the time/yield limits of low carbon 18/8 chromium/nickel steels with heat-resisting steels.*

of the values is usually so considerable that the 100,000 hr. value of the hard-annealed materials coincides with that of the soft-annealed materials, but quite often the value is less than in the soft-annealed condition.

This experience led to the method, which is to aim at a very low tensile strength in annealing in order to guarantee good long-term values coupled with a long life of the parts being treated. On the other hand there is no reason why one should not aim at a high long-time strength for castings with a relatively short life. The difficulties encountered with rolled and forged materials in reducing, as far as possible, the yield point by economic heat treatment, give a certain superiority (as regards long-time properties) to those cast-steel alloys which can be annealed, as they possess lower yield points for the same chemical composition.

The comparative testing[6] of rolled steel containing 0.6 chromium and 0.45 per cent. molybdenum, having a yield point of 43-ton per sq. in. and a cast steel of the same alloy content with a yield point of only 18-ton per sq. in. is demonstrated in Fig. 7. The appearance of ductile fractures on the cast steel samples throughout the whole testing time at 550 deg. C. is remarkable. The rolled steel of the same composition, but with relatively high yield point, breaks within the first 1,000 hr. without deformation, but becomes tougher the longer it is worked. This is obviously connected with segregation of Mo/Cr/C compounds which are still in *statu nascendi* at the initial state, but are forced into complete segregation by prolonged heat treatment. The continuous improvement of toughness begins when the dispersions coagulate. Such coagulations are most noticeable in alloys containing chromium.

Chromium-free cast steels with good weldability, containing either 0.4 molybdenum, or 0.4 Mo, 0.25 per cent. vanadium, or 0.65 molybdenum, 0.4 per cent. vanadium, are always quenched from high temperatures (between 950 and 1,020 deg. C.) in oil or air, according to their shape, in order to dissolve the Mo/V-carbides. The aim of subsequent tempering must be to segregate and evenly distribute these carbides as far as is possible. This will be achieved, only in practice, by tempering for low tensile-strength. Baerleken[7] shows in his temper-diagrams of rolled steels, of the Mo/V and Cr/Mo type, which are comparable with cast steels of the same chemical composition, that the most favourable temperature for tempering is about 750 deg. C. and that the temperature tolerance is very small.

The fact that all molybdenum-containing cast steels of group 2 (see table 1), namely the ferritic alloys, soften in the temperature range of 750 deg. C. is evident. This might possibly constitute the best formation temperature for Mo_2C when tempering for the usual times. Table 1 also gives a survey of the mechanical properties obtained at room temperature for high-temperature ferritic cast-steels of group 2.

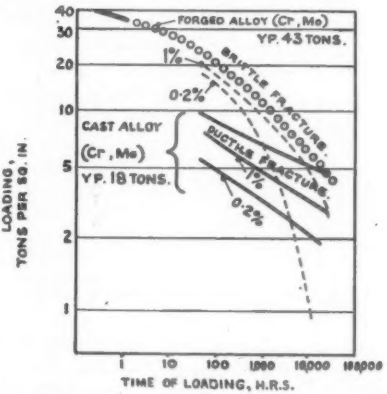

FIG. 7.—*Comparison of two steels containing 0.6 per cent. Cr and 0.45 per cent. Mo in the as cast, and forged state, with varying time of loading.*

The annealing of austenitic high-temperature steels of the type 18/8 Cr Ni is carried out from 1,050 to 1,100 deg. C. in water, and when the carbon has been stabilized by Ta/Nb, because this heat treatment is intended in the first instance to relieve the heterogeneous conditions of structure which develop prior to the solidification of the metal in the mould. The minimum heating time should be one hour, because long distances of diffusion have to be overcome in the coarse-grained cast-structure. After homogenizing and the solution of the carbides at high temperatures, and in the course of working these materials at a temperature range of 600 to 700 deg. C., a segregation of special carbides occurs, which further increases the long-time creep-resistance of the austenitic condition. Traces of delta-ferrite, which might possibly be present, decompose, when held longer at the high working

temperature, and form sigma phase which is undesirable, for it causes a reduction of the notch-impact value (increased brittleness). The avoidance of the sigma phase formation can be achieved by lowering the chromium content to about 16 per cent., and increasing the nickel content simultaneously to 13 per cent. with additions of Ta/Nb as carbide stabilizers. The heat-resisting high-temperature furnace materials do not require any heat treatment prior to their use, as possible crystal segregations, originally existing, would homogenize themselves during the working life in the temperature range up to 1,200 deg. C., and the solution equilibrium for the carbides at the existing temperature range would be reached.

TABLE 1.—*Chemical Composition and Mechanical Properties of High-temperature Cast Steels at Room Temperature.*

Low-alloy cast steels.	C, per cent.	Si, per cent.	Mn, per cent.	Cr., per cent.	Ni, per cent.	Mo, per cent.	V, per cent.	Yield point, tons per sq. in.	Tensile strength, tons per sq. in.	Elongation, per cent.	Contraction, per cent.	Brinell Hardness.
1	0.19 to 0.25	0.30 to 0.50	0.80 to 1.0	max. 0.3	—	0.4 to 0.5	—	14	28	22	50	150
2	0.17 to 0.22	0.30 to 0.50	0.70 to 0.90	max. 0.3	—	0.35 to 0.45	0.2 to 0.3	19	32	18	40	160
3	0.17 to 0.22	0.30 to 0.50	0.70 to 0.90	max. 0.3	—	0.6 to 0.7	0.35 to 0.45	20	35	18	40	160
4	0.19 to 0.25	0.30 to 0.50	0.50 to 0.70	0.1 to 1.1	—	0.4 to 0.5	—	19	35	17	45	230
5	0.19 to 0.25	0.30 to 0.50	0.50 to 0.70	1.2 to 1.5	—	0.55 to 0.65	0.2 to 0.3	38	47	12	45	230
6	0.07 to 0.15	0.30 to 0.50	0.40 to 0.60	2.0 to 2.5	—	0.9 to 1.0	—	24	35	17	50	200
7	0.19 to 0.25	0.30 to 0.50	0.30 to 0.50	1.0 to 1.2	—	1.0 to 1.2	0.45 to 0.55	28	41	14	40	210
8	0.20 to 0.25	0.15 to 0.40	0.40 to 0.70	11.5 to 12.5	0.4 to 0.8	1.2 to 1.4	0.25 to 0.35	38	47	16	40	210
9	0.08 to 0.13	0.30 to 0.50	0.40 to 0.70	5.0 to 5.5	—	0.45 to 0.55	—	32	44	18	50	210
10	0.08 to 0.13	0.30 to 0.50	0.50 to 0.70	9.0 to 9.5	—	1.1 to 1.4	—	32	44	16	40	210

Summary

Concluding, it must be said that little new information might have been given to the specialist for creep-resisting steel castings, but it has been the intention to offer a survey of this field to the designer and the foundryman and to demonstrate to them the efficiency of steel castings. The widening of the field of application of ferritic cast steels into the operational temperature range of nearly 600 deg. C., with worth-while long-time creep-resisting properties can be regarded as a successful achievement of recent years. In addition there existed a need for figures and safety factors which have proved to be correct in practice and to outline the present state of experiments, most of which extend over more than 25,000 working hours.

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Oxygen Flash-smelting Process

Application to Nickel Production

The employment of tonnage-oxygen plants in the field of metallurgy is by no means confined to the smelting and refining of iron and steel. One of the most impressive technical developments of recent years has been undertaken by the International Nickel Company of Canada, Limited, at its combined nickel and copper smelter at Copper Cliff, Ontario, Canada, and is known as the oxygen flash-smelting process. By employing this device a single process unit is now able to perform the work of two separate units by combining the functions of the roaster and the matte-smelting furnace in a single operation.

The finely-divided flotation concentrates (*i.e.*, copper and nickel sulphides with some iron sulphide) are mixed with finely-ground silica and injected into a stream of tonnage oxygen and ignited. The heat developed by the combustion of the sulphides in oxygen is sufficient to melt the products of combustion, so that beneath the oxygen-sulphide flame the materials separate into matte and slag in the same way as in the old matte-smelting furnace. The action of the oxygen flash-smelting furnace is continuous, molten matte and slag being drawn off regularly to keep the level more or less consistent.

Owing to the speed of operation and the high temperature of the flame, the first-formed slag is not quite so "clean" as the slag formed in the old matte-smelting furnace, it tends to be rather heavily contaminated with copper. However, an ingenious way out of this difficulty has been found. At the exit end of the chamber a second oxygen "gun" is installed which burns sulphides of iron in tonnage oxygen. This forms molten iron oxide which "sprays" the slag just before it leaves the vessel. The extra iron oxide is able to replace the copper content of the slag and force this copper into the metal. The total volume of slag may be thus increased somewhat, but the saving in copper amply offsets this.

GUY MOTORS, LIMITED—Mr. William Edmund Bullock has resigned as production director, but will continue to serve the company as consultant engineer.

G

New Furnace at Briton Ferry

The first step in the £1,500,000 scheme for works extension and modernization recently commenced, at Briton Ferry Steel Company's Albion Works, with the erection of a new 100-ton furnace. A basic open-hearth furnace of Martz design, it will eventually be fully equipped with all modern ancillaries for high production yield of special steels; the total cost will be one third—£500,000—of the overall cost of the scheme. It is anticipated that many features of the furnace—which will be "all basic" to combat high temperatures and corrosion from waste gases—will be completed by June 1958. Initially, the furnace will be comparatively costly, however, its extra life and lower cost of maintenance will more than pay for it over a long period of operation. At present, production figures stand at 5,000 tons a week; however, once in full operation, output will increase to 6,000 tons a week with a corresponding increase in labour force from 750 to 850. Construction of additional soaking pits for heating ingots for rolling will be required, while other furnaces at the works, are to be modernized.

Many features of the new furnace will depart from standard UK practice— the main development is to provide a powerful low-pipe flame with turbulent effect upon the bath of steel, yielding the greatest melting and refining force, coupled with the minimum corrosive effect upon expensive refractory structure of the furnace.

Views on European Free Trade

Sir Peter Roberts, M.P., the Master Cutler, said at a one-day school at Wortley Hall Labour College, near Sheffield, on May 18, that Britain should stay out of any free trade area until the countries concerned had built a standard of living equal to that here. He said, "The continental countries are past masters at getting round rules and regulations. We never know what goods we might get dumped in this country," and added, "The Iron and Steel Community is fast becoming one enormous cartel." Sir Peter considered that living standards would drop if the UK entered into the plan, and he would prefer British firms to invest in the Commonwealth for their raw materials. He thought that the free trade area should be treated in the same way as the Iron and Steel Community—by sending observers.

Mr. K. Dallas, of the TUC Research Department, said Britain could not afford to stay out of the Free Trade Area. One-eighth of Britain's exports went through the six European countries definitely starting a free trade zone, and the removal of tariffs between these countries would give Germany, one of the participants, a great advantage over us. There would be a harmonizing of social levels in Europe. He said that six countries had already agreed to adopt a 40-hour week to make industrial competition more fair.

JOHN HOLT & COMPANY (LIVERPOOL), LIMITED, have been appointed Nigerian distributors for Guy Motors, Limited, Wolverhampton. The name of John Holt has been associated with the West African scene since 1862. when a handful of traders established themselves along the coast. To-day the company has headquarters at Lagos, Kano, Port Harcourt, Warri and Benin, with some 150 agents deployed over the 370,000 sq. miles territory. The organization also has important ramifications in Ghana and the Cameroons and is one of Britain's biggest import-export houses.

Trade Gap Widens

While UK export prices remained steady in April, import prices rose resulting in a movement of the terms of trade (the ratio of import to export prices) against the UK. The export price index for April was unchanged at 110 (1954=100) for the third successive month. The import price index, which had fallen by one point to 110 in March, returned to the February level of 111, giving a rise of one point to 101 in the terms of trade index.

The most spectacular rise in import prices has been in fuels. The higher c.i.f. value of imported oil caused an advance in the index from 115 in November to 145 in April. Imports in April were worth £349,700,000, £12,000,000 less than in the previous month, but only 1 per cent. below the monthly average for the first quarter. The increase in imports of 7½ per cent. in value between the first four months of the year and the same period of 1956 is significant.

While imports remained high in April, exports were worth £272,200,000, £25,000,000 less than in March and 2½ per cent. below the first-quarter monthly average. With re-exports falling very sharply to a third of the first-quarter average, the visible trade gap rose to nearly £69,000,000, against £32,000,000 in February and £48,000,000 in March.

The trends of overseas trade in the first four months of the year were not materially affected by the April figures, having, over the period, continued to rise, though less rapidly than in 1956.

Iron-ore Imports

Iron-ore imports in April, and the totals for the first four months of this year and last are shown below.

From	Month ended April 30.	Four months ended April 30.	
	1957.	1956.	1957.
	Tons.	Tons.	Tons.
Sierra Leone	95,275	250,014	242,355
Canada	7,700	165,669	130,272
Other Commonwealth countries and Eire	2,459	5,312	7,532
Sweden	293,507	1,197,766	1,130,218
Norway	15,087	32,765	65,028
Western Germany	—	2,960	—
France	71,972	188,904	228,355
Portugal	9,636	35,813	37,866
Spain	109,053	293,504	348,046
Algeria	130,186	491,389	513,138
French West Africa	58,680	278,527	226,022
Tunisia	95,785	270,012	280,156
Northern Morocco	23,040	96,723	66,657
Southern Morocco	57,040	148,064	117,811
Liberia	50,680	134,278	152,084
Brazil	50,144	179,089	184,062
Other foreign countries	103,561	182,770	432,456
TOTAL	1,173,805	3,953,559	4,162,058

A CONTRIBUTION OF £1,200 towards the Welsh National Eisteddfod, to be staged in 1958, was recently made by the directors of Richard, Thomas & Baldwins, Limited, of Ebbw Vale. Sir Ernest Lever, chairman of the company, Mr. N. F. Spencer, managing director, Mr. G. A. Young, assistant managing director, and Mr. W. F. Gilbertson, deputy general and works superintendent (Ebbw Vale section), have accepted the executive committee's invitation to serve as honorary presidents.

European Investment Casters' Association

Conference Sessions and Social Events at Stratford on Avon, May 19 to 23

The European Investment Casters' Association, a loosely-knit technical association of casting producers, was really "put on the map" of the world's foundry organizations at the conference held in Stratford on Avon last week, with headquarters at the Welcombe Hotel. Coming from nearly all the countries of Western Europe, about 130 members attended the four-day event, many of them accompanied by their ladies. Practically all the investment foundries of this country, including those attached to aircraft firms, were represented.

The meeting was ushered in by an informal party after dinner on Sunday evening, which well served delegates as a means of renewing old and making new acquaintances among the assembly. At this—and in fact at a number of functions of the conference—Joseph Lucas, Limited, Birmingham, were the hosts, through Dr. J. D. Jevons, of that firm, who, at a previous gathering of the Association, had been appointed convener of the UK meeting.

First Day

On Monday morning, the technical sessions commenced under the presidency of Mr. W. H. Sulzer (of Sulzer Brothers, Limited, Switzerland), who made a short speech of introduction in French, German and English. Thereafter, the official language of the conference was English, with immediate translation into French (and on occasions, German, also) as required by the delegates, about half of whom were from overseas. Mr. Sulzer first introduced Dr. E. A. Watson, O.B.E., representing the hosts, who welcomed the visitors and provided a preface for the technical deliberations in the form of the following address:

Welcoming Address

Dr. Watson said this was the fourth meeting of the European Investment Casters' Association; the first was convened, through the enthusiasm and labour of Mr. Sulzer, in 1954 in Paris, when the attendance numbered 30; the second was in 1955, in Zurich, with Sulzer Brothers acting as host company to an attendance of 30, and the third was held last year in Eindhoven, with the Philips concern as hosts, when 58 were present. This year, the Joseph Lucas organization was glad to welcome foreign delegates to England, and particularly to Stratford on Avon with its Shakesperian associations (about which overseas visitors often seemed to know much more than most of those who lived there!).

In opening the conference he had to admit to being somewhat of a layman, as he did not have the problem of getting to grips with the investment-casting process. However, he knew enough to realize its importance and to recognize that it merited the close study which was being given to it by the Association. It would not surprise the assembly to be reminded that the process, although sometimes regarded as of recent origin, was in reality very old indeed, dating back to what might be regarded in Europe as prehistoric times and even in Europe itself, going back nearly a thousand years. Last year he had spent a few days in the German town of Hildesheim and, in the cathedral there, was fortunate to see some outstanding examples of work produced by the investment-casting process. By the courtesy of Mr. Hagmaier, of the firm of Robert Bosch GmbH, who have a factory in Hildesheim, he was able to show the assembly illustrations (Figs. 1 to 3) of this work and give a brief description of it.

Art-founding Examples

The first example (Fig. 1) is of a pair of bronze doors which were produced in A.D. 1015 at the order of Bishop Bernward, of Hildesheim, who held the See from 992 to 1022. The doors, which are beautiful pieces of art as well as being outstanding examples of the founders' craft, are lost-wax castings, each measuring 15 ft. 6 in. high by 4 ft. 1 in. wide. The thickness varies between 1⅛ and 1¼ in. on the frame and about 1 in. for the panel itself, while each door weighs nearly two tons. The alloy employed, although doubtless nominally the same for both doors, actually varies as between them but is primarily a copper/tin/zinc bronze with a large lead content. Particulars are given in an account, dating from about the year A.D. 1100, of the process employed for melting the alloy and for preparing the moulds, the melting being carried out in iron pots lined with several thicknesses of clay baked on successively. The pots were packed round with wood charcoal, bricked in and the air supplied by bellows. The description emphasized that strong men were required to operate the bellows!

The second illustration shows a bronze column, also produced at the order of Bishop Bernward in A.D. 1020, for which he may have found the inspiration during a journey to Rome in A.D. 1001. This column measures 12 ft. 4 in. high by 1 ft. 10¾ in. dia. It is, of course, hollow but nevertheless weighs nearly 6 tons and is, therefore, an outstanding piece of work. The metal composition of this is somewhat different from the doors, consisting primarily of 69.8 per cent. copper, 23.7 per cent. tin, and only 5.34 per cent. lead.

The third example (Fig. 3), artistically perhaps the best of the trio, dates from somewhat later, viz. A.D. 1250, and takes the form of a large bronze font used in the cathedral of Hildesheim. The creator of this magnificent piece of work is unfortunately unknown. It, too, was produced by the lost-wax process although in this case, a certain amount of hand chasing has been applied to the outside surface. It was cast in a so-called

FIG. 1.—*Bernward bronze doors at Hildesheim Cathedral, reputed to have been made in* A.D. 1015. *Each cast in one piece, including the lions' heads, they are* 15-*ft.* 6-*in. high,* 4-*ft. wide and weigh about two tons. Accurate records do not exist, but it is certain that the doors were produced by the investment casting lost-wax process. The reverse sides are rough and uneven; the left door is slightly curved which suggests defective packing of the mould during casting.*

The left door portrays in its eight pictures (starting at the top), the story from the Old Testament of our progenitors and their two sons: (1) Creation of Adam; (2) God leads Eve to the Man; (3) Fall of Man (Eve gives Adam the apple from the forbidden tree, the serpent and the dragon being symbols of evil in the tree); (4) God's Judgment (God calls Adam and Eve to account, Adam accuses Eve and she, in turn, the dragon at their feet); (5) the Angel banishes Adam and Eve from paradise; (6) Adam works while Eve nurses her child; (7) the offering of Cain and Abel, and (8) the Fratricide, Cain slays Abel.

The right side symbolizes the Redemption and Ascent, according to the New Testament. Starting from below and ascending, there are shown: (1) Mary's Annunciation; the Angel brings Mary the message; (2) the birth of Christ, pictured in a city; (3) the Adoration of the Kings; (4) the presentation in the Temple (Simeon takes the child from the hand of its mother); (5) Christ before Pilate (the dragon on the shoulder represents the influence of evil); (6) the Crucifixion of Jesus (the soldiers offer vinegar; on the extreme left stands a mourning woman); (7) women at the Grave (the Angel announces the Resurrection to the women in front of the empty tomb), and (8) the appearance of Christ to Mary Magdalen.

gold bronze—an alloy with high-zinc content which fact has unfortunately led to decomposition phenomena in places of high-zinc concentration.

Dr. Watson continued by saying that there are in Europe a number of other similar examples of ancient investment castings totalling some twelve or more in all, most of the remainder being in Italy, but there was ample evidence, not only that the art of mould preparation had reached a very

high order, but also that the metal melting and pouring facilities were very highly developed indeed. "Perhaps, if we measure up present-day activities by comparison with the work of these ancient craftsmen, we may acquire a sense of modesty, which is sometimes good for our souls," he concluded.

Process Advantages

Passing on to outline the advantages and disadvantages of the investment process, Dr. Watson said, the first and most obvious advantage was that parts can be produced by this process which could not possibly be made in any other manner. As compared with ordinary sand moulding, the elimination of the joint in the mould permitted a higher degree of accuracy to be obtained and this was aided by the fact that the master die in which the wax patterns were made was not subjected to any appreciable wear. This opportunity for obtaining greater accuracy made possible the elimination of machining operations, while the two advantages combined rendered it feasible to produce parts at prices which could not be achieved if difficult machining processes were carried out. A third advantage—frequently the most important of all—was that parts could be produced to high orders of accuracy in alloys virtually unmachinable, whether by reason of their hardness or other behaviour under normal cutting operations.

It must, however, be remembered that the process was inherently an expensive one and that no saving in cost could be expected if it was used to produce a part which could be manufactured with reasonable ease by one of the normal methods of casting or forging, followed by machining. Its use was applicable where particularly difficult machining could be avoided, but, in general, an investment casting should be designed on the drawing board and it was, perhaps, one function of the present conference to indicate to designers how this could be done most effectively.

Practice Differences

There were, Dr. Watson said, certain differences in practice between this country and the Continent of Europe. On the Continent, investment castings had been used for some years for machine parts, for domestic appliances and for everyday use, while in this country, the use had been largely confined to the aircraft industry. This brought with it a very significant difference in the outlook as regards costs and selling price. For an aircraft component, many precautions were necessary on the metallurgical side, and 100 per cent. X-ray examination of the product was practically universal. Recently, the industrial application of investment casting had received increasing attention in Great Britain; this aspect could well be studied even more seriously, but a different approach was necessary to that which was common in the aircraft industry.

It was a matter of deep regret to him personally and also to the organizers of this conference that, as most of the work in the UK was on aircraft components, security regulations prevented any general works visits to foundries operating the processes, but he hastened to assure delegates this was not the result of the wishes of the founders themselves. He expressed the hope that in the

FIG. 2.—*The Christ column, introduced by Bishop Bernward, to Hildesheim Cathedral. Without its capital, the column measures* 12-*ft.* 4-*in. high, has a diameter of* 22¾-*in. and weighs about* 6 *tons. The column was also produced by the investment casting* (*lost-wax*) *process.*

The column rests with its protruding foot on an attic basis. On the four corners were male figures of which only one is preserved. They represented the four original rivers, Euphrates, Tigris, Physon and Geon which correspond to the four cardinal virtues, justice, valour, prudence and moderation. Above them is wound in an eight-fold spiral, a wide band on which 28 representations from the life of Christ are depicted, each nearly 2-in. high. These show events from the baptism in the Jordan to the entry into Jerusalem.

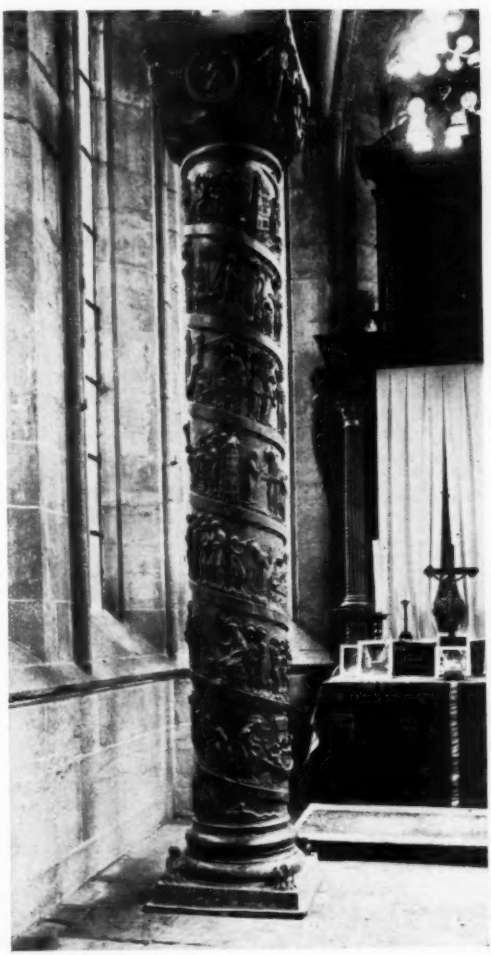


FIG. 3.—*Baptismal font, yet a further investment casting located in Hildesheim Cathedral. The font is a brilliant production of the casting and chasing art of the 13th century, being created in 1250 by an unknown master. It served up to the destruction of the cathedral as a baptismal font and will be used again as such after completion of reconstruction.*

The basin itself is carried by four kneeling men who represent the streams of paradise. The outer wall and the cover are decorated with rich and expressive reliefs, which show events from the Old and New Testaments in connection with baptism and Christian charity. It is cast from so-called gold-bronze. Although produced by the lost-wax method, the figures and the whole surface were worked on, and extensively chased, after casting.

contribution which British firms were able to make to the papers and discussions during the conference, some amends might be made for these unfortunate circumstances.

Finally, in declaring the conference open he thanked the members of the organizing committee —Mr. R. W. N. Danielsen (of Deritend Precision Castings, Limited), Mr. M. Riddihough (Deloro Stellite, Limited), and Dr. Jevons, who had all worked so hard to make the UK meeting possible.

Technical Sessions

The remainder of Monday's programme consisted of the presentation and discussion (with a break for luncheon) of four papers:* "Waxes for Investment Casting," by E. H. G. Sargent (Astor Boisellier & Lawrence, Limited (UK)); "Refractories and Moulding Materials for Vacuum Casting," by H. D. McIntire (Battelle Memorial Institute, USA); "Applications of Statistical Control in the Production of Precision Investment Castings," by I. V. di Sambuy (Italy), and "Influence of Vacuum Properties of Various Materials," by A. J. Kiesler and W. F. Moore (General Electric Company, New York). Mr. McIntire was unable to be present and in his absence his paper was read by Mr. W. Siegfried from Battelle, Switzerland. In the unavoidable absence, also, of Mr. Kiesler and Mr. Moore, their paper was read by Mr. Riddihough.

* All the Papers are to be printed in this JOURNAL.—Editor.

Test-bars and Specifications

Also included in the Monday's sessions was a discussion on the proposed unified action to be taken by the Association on the question of specifications and test-bars for investment castings. Mr. DI SAMBUY reported for the small committee appointed at the last meeting to deal with this matter, in the following terms:

Preliminary discussions held by the British firms' representatives seemed initially to have recorded failure on the proposition to accept European standard specifications for investment castings, a decision, however, that had lately been reconsidered and re-discussed—according to information received from Mr. Richards, secretary of the Iron and Steel Industry Standards Committee, who now wrote that there was general agreement amongst producers of investment castings that standards for castings, and possibly for the materials, were desirable. On this basis there would shortly be set up a committee to propose such British Standards and this

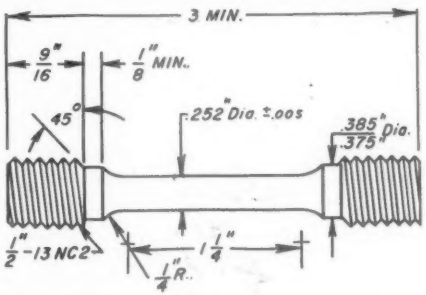


FIG. 4.—*Design and dimensions of an American tensile test-bar recommended for application to precision investment casting.*

Notes accompanying the sketch stipulate the following: Test-bar concentricity shall be agreed between manufacturer and purchaser; threads may be machined but this must be done in a manner to minimize stresses in the gauge length; the gauge length section will be cast to size unless otherwise specified and it is recommended that the diameter of the gauge length be decreased a maximum of 0.003-in. at the centre to facilitate mid-point fracture, it is permissible to increase the 0.375- to 0.385-in. shoulder diameter to a maximum of 0.5-in.

would be interested to hear of any developments in the work of the EICA.

German Work

During last year's GIFA exhibition in Düsseldorf, at a session called to discuss propositions from four members of EICA's sub-committee for specifications, a scheme of work was proposed. Later, German investment casters had met frequently, the last time being in Frankfurt on February 15. Here, the German members had agreed on the following points: (1) Specifications should be issued on three case-hardening steels, GS 38, EN 15, and 15 C Ni 6 (material Nos. 0562, 5622 and 5919 respectively); (2) on four heat-treatable steels, GS 45, GS 60, 42 Cr Mo 4, and 34 Cr Ni Mo 6 (material Nos. 0619, 0796, 7995 and 6582 respectively); (3) nitriding material: 31 Cr Mo V 9 (No. 8519); (4) It was thought the specifications should only give figures for tensile, yield-point and elongation; no impact test being specified; (5) the specification for investment casting would be preceded by letters "FG" to avoid confusion with "GS" specification for normal steel castings.

Continuing his report, Mr. di Sambuy said that he did not agree with the fact that no specification was given on impact, but he felt that the other propositions were acceptable, meeting the conditions requested. As far as tensile test-bars were concerned, Dr. Jevons had reproduced an illustration (Fig. 4) of a cast-to-size bar, specified by the American Investment Casting Institute. From personal work, he was hoping to be able to submit some figures on load/temperature/impact tests on investment castings, but unfortunately, since this work had not been finished, it would have to be referred to next year's meeting.

He took the opportunity of drawing members attention to the fact that he considered they ought to agree on a standard impact test-bar (cast-to-size) suitable for investment castings in order to avoid present confusion of different bar sizes, and proposed this as a further item for consideration by the sub-committee.

Mr. di Sambuy finished his report with the wish that investment casters might anticipate the European Free Trade Zone by having very soon common specifications concerning their products.

Test-bar Status

There followed considerable discussion on the specification and test-bar report, much of that on the test-bar section being devoted to considering whether the bar should only represent the metal melted or should in some way try to evaluate the castings. A vote taken at the meeting resulted in 36 to 16 in favour of separately-cast rather than cast-on test-bars, though it was conceded by some that cast-on bars could be used to assess special properties of the casting—witness, for instance, the American procedure of casting a bend-test bar on every "tree" for certain alloys.

During the Monday's sessions, also, Mr. Sulzer mentioned the availability to members of prints of a photograph of the Association's stand at last year's Düsseldorf foundry exhibition and mentioned that copies of a late conference paper of American origin on "Health Hazards in Investment Casting" could be sent to delegates requesting them.

Tuesday Sessions

On the Tuesday, technical sessions were continued, with two papers being presented and discussed in the morning and the final two in the afternoon. Thus were presented "A Tour of P.I. Castings," by D. H. Armitage (P.I. Castings (Altrincham), Limited, UK); "Speaking of Investments," by Meerkamp van Embden (N.V. Philip's Gloeilampenfabrieken, Holland); "Investment Casting of Non-ferrous Metals," by E. Weisner (Fürstlich Hohenzollernsche, Germany) and "Comparative Studies of Various Methods of Manufacturing Small Machine Components," by R. Schwalbe and P. Weist (Zentroguss GmbH, Germany).

At some of the sessions, Mr. Meerkamp van Embden deputised in the Chair for Mr. Sulzer. During the second day's proceedings, Mr. Sulzer announced that changing business commitments would prevent his accepting further responsibilities with the Investment Casters' Association, much as he regretted the change. He proposed Mr. Meerkamp van Embden as his successor. The proposition was duly seconded and carried, it being the first job of the new president to voice members' gratefulness to Mr. Sulzer for establishing the Association, largely as a result of personal initiative and drive, and to wish him success in his new spheres of activity.

Other Business

On the Wednesday morning, further discussions took place on the constitution of the Association and on its activities in relation especially to specification proposals. The working committee was asked to continue its representation and "*rapporteurs*" or "contact men" in the various countries were asked to continue their good work, with the exception that Mr. Armitage (of P.I. Castings (Altrincham), Limited) agreed to take on that rôle in the UK in future instead of Dr. Jevons, who asked to be excused.

The venue for next year's conference of the Association is likely to be Belgium, the period before the World Fair seemingly offering the best choice for meeting dates. Other business discussed included: Proposals for the canalization into a central depot of literature concerning the investment-casting process and the preparation of Association propaganda booklets; the American Institute has offered copies of its design book to members; samples of castings representing new applications of the process may be admitted for study at the next conference. Future exhibition policy, and emphasis on "mechanical properties" as the theme of next year's conference concluded the items discussed at the meeting.

Social Activities

Beginning with the informal gathering on the Sunday evening (already referred to), the pro-

European Investment Casters' Conference

gramme had a full complement of social events, including special tours for the ladies. In this series, in glorious weather, a visit was made to Warwick Castle on Monday morning, followed by a tour of Stratford (including Anne Hathaway's Cottage and Shakespeare's birthplace) in the afternoon. That evening, the Memorial Theatre at Stratford was visited for a performance of "King John."

Next day, the ladies visited Oxford by motor coach, touring the Colleges. That evening, the annual banquet of the Association took place at the Welcombe Hotel, attended by about 160 delegates and guests. Here, during the speeches following dinner, Dr. Watson praised Mr. Sulzer's efforts on the Association's behalf over the past four years and, in turn, welcomed Mr. Meerkamp van Embden and gave him the meeting's best wishes for the future. Mr. Danielsen then presented a silver salver to Mr. Sulzer from the Association as a memento of his presidency. Mr. Sulzer made suitable acknowledgment and voiced delegates' appreciation of the help given to the Conference by Joseph Lucas, Limited, the hosts, by Mr. G. J. Lee, Mr. M. Riddihough and Miss Molloy who had shouldered so much of the organization and executive duties. Mr. Meerkamp van Embden mentioned how large was the progress registered since the time, four years ago, when all met as "militant" competitors. Particularly—speaking in Spanish—he welcomed the Spanish delegation.

To conclude the record of conference activity, there was a whole-day tour of Cotswold country on the Wednesday, open to ladies and their menfolk or, alternatively, visits in the afternoon to two plants in Birmingham of Joseph Lucas, Limited.

There is no doubt that the whole proceedings in the UK proved worthy followers of events held in previous years on the Continent and auger well for future co-operation among members of this newest foundry technical association.

Rights Issue for Nuclear Energy Programme

Treasury consent for a rights issue by John Thompson, Limited, combustion and general engineers, of Wolverhampton, has been obtained. The issue will be on the basis of one new 5s. ordinary share at 25s. for every seven held. The issue of 1,048,227 ordinary shares will raise about £1,300,000 to enable the company to fulfil its new commitments for the nuclear energy programme and to provide additional working capital to finance the increase in turnover.

There is no intention at present to issue the balance of the authorized capital—which is being increased by £750,000—leaving it available for future needs. The directors expect that the current year's earnings will be sufficient to maintain the dividend rate on the increased capital. Work to be undertaken by the company in connection with atomic energy projects will have a value of between £9,000,000 and £10,000,000. This is to some extent additional to the company's normal business, the turnover of which has increased by over 70 per cent. in the last four years.

Group profits advanced to a record £2,550,961 (£2,113,866) and the 25 per cent. dividend (15 per cent. final) is maintained.

Publications Received

Steel Review, April 1957. Published by the British Iron and Steel Federation, Steel House, Tothill Street, London, S.W.1; price 3s. 6d.

The principal article in this issue is on the Russian steel industry. It is magnificently illustrated in colour, and is divided into three parts. The second part is on management and labour and it is disclosed that the differential in wages between a Russian labourer and a highly-skilled man is of the ratio of 6:40.

This in the reviewer's recollection is greater than the ratios existing in the Victorian era, when a skilled man's wages were double those of the labourer. In Russia, the directors of the large works are members of the trade unions, but these do not discuss wages, only such matters as safety and amenities, very much like the joint consultative councils in this country. Where dissatisfaction with wages is voiced by a group, they are told to undertake a training course which will qualify them for a more-highly-paid job. This is a very interesting issue of the Review and is well worth study by all industrialists.

Work-study and Industrial Engineering. Published by Management Publications, Limited, 8, Hill Street, London, W.1; price 2s. 6d.

This is a new monthly journal, designed to provide a medium for the exchange of information on important contributions to the efficiency of business. It is intended to bring to the work-study engineer news of recent applications throughout industry and keep him abreast of new techniques and methods, based on mathematical and other sciences that are now coming to the fore. This first edition contains, amongst its articles, "Technique of Introducing a New Materials-handling Method," and "Work-study and Human Relations." The journal is the official organ of the Society of Industrial Engineers and the Work-study Society. Reports of the sort recorded in this type of journal, in the reviewer's opinion, must always tend to be platitudinous, as otherwise they have no meaning common to a diversity of industries.

Nylon Goes to Work. Issued by British Nylon Spinners, Limited, Pontypool, Mon.

This, with the exception of the last two pages, is a non-technical publication, wherein the mechanical properties of nylon are set out. From these it is learnt that the strength of nylon is 44 tons per sq. in.; it has good abrasion-resistance properties, and it loses 10 to 15 per cent. of its strength when wet but recovers on drying. In this well-illustrated brochure the first industrial application to be shown is that of filter cloths, but apparently these are not used in connection with dust extraction. Nylon ropes and nets come in for discussion. Nylon protective clothing is an obvious industrial application, which is increasing in popularity. Finally, military—not industrial—applications are shown, such as nylon parachutes and crash nets on aircraft carriers.

"Broomwade" New Bulletin, Vol. 20, No. 2; issued by Broom & Wade, Limited, High Wycombe, Bucks.

The main portion of this publication deals with the use of the company's portable compressors in rebuilding in the bombed area around St. Paul's Cathedral. Overseas interest is sustained by notes on the firm's compressors in use in Malta and Australia.

ASSOCIATED ENGINEERING HOLDINGS, LIMITED—Mr. J. L. Hepworth has been elected a director.

New Design of Shot-blast Plant

*By R. Michie, A.M.I.Mech.E., M.Inst.F.**

Many steel castings of complicated form and design would not be acceptable to users unless all traces of sand had been removed by suitable apparatus. For example, castings embodying an oil well to carry lubricant would be regarded as imperfect if sand grains were present. The old method of hand fettling had and still has its value, but the shot-blasting has the additional advantage that it improves the appearance of the castings. The treatment also reveals many small surface imperfections that might not otherwise be observed, and this is all to the advantage of the user, enabling him to judge the significance of these blemishes. Moreover, the steel founder is able to see for himself the precise location of these defects and take steps to prevent their recurrence. Developments in other classes of steelfoundry equipment have necessarily had to be paralleled by developments in cleaning methods, and an account of development work in this direction carried out at one of the largest British steel foundries, is recorded in what follows.

Edgar Allen & Co., Limited, Sheffield, have recently put into operation a complete new shot-blast plant for cleaning steel castings. It replaces a low-pressure plant of obsolete design, and works in conjunction with an existing Jackman high-pressure plant which deals with steel castings of larger weights and dimensions.

The whole of the shot-blast plant and air-washers are housed in a new building adjacent to the fettling shop. This layout has freed space under the overhead cranes totalling 4,000-sq. ft., which was formerly occupied by low-pressure shot-blasting equipment. In the consideration of this equipment, full cognizance has been taken of section 47 of the Factory Act 1937, with special attention to "The Blasting (Castings & Other Articles) Special Regulations 1949, No. 2225." It is considered that the plant meets the requirements of the Special Regulations in all respects.

General Description

At the Sheffield works, there are four shot-blast rooms (Fig. 1) installed by J. W. Jackman & Company, Limited, each 12 by 12 by 9 ft. high, independently constructed and built of cast-iron tank plates, except for the front which consists of a door of mild-steel plate, suitably reinforced and arranged to lift vertically to expose the full height of the room. The lowest row of the three walls of cast-iron plates is protected by renewable wear plates ½-in. thick. The door is built so that ventilation air can enter the room through horizontal slots which are properly baffled to prevent escape of abrasive (Fig. 1). Hoisting of the door is achieved by two ropes on winding drums driven by gears from a geared motor, having an electro-magnetic brake on the high-speed shaft. In addition, two safety ropes are provided to give protection against accident. When the door is at the top of its stroke, a limit-switch operates to brake the motor and to de-energize a solenoid, which then allows a spring-loaded positive stop to lock the door.

Door Joints

The door is fitted with soft-rubber joints. At the bottom end of its movement, rollers fixed on the door come into contact with cam faces on the chamber structure so that the soft-rubber joints are pushed forward into contact with the room frame, thus making a perfect seal. The main door is provided with a hinged access door and a special window protected against the effect of blast by a renewable transparent strip. When the access door is open, a limit-switch is operated so that the main door cannot be lifted.

FIG. 1.—*Battery of four Jackman shot-blast rooms, arranged side by side, at Edgar Allen & Co., Limited.*

* The Author is plant engineer, Edgar Allen & Co., Limited.

FIG. 2.—*One of the shot-blast rooms—note the baffled slots, located in the door, for ventilation purposes.*

Dust Extraction

A number of horizontal slots are cast in the rear wall of the chamber (Fig. 2) and through these dust-laden air passes out of the chamber into a closed outlet baffle-box from which there is a connection to the dust exhausting system. Dust-laden air is thus fully under control, its path being through horizontal slots in the door, horizontally across the room and out through corresponding slots in the rear wall of the chamber—a path dictated by the site conditions. Since the front of the chamber consisted of a full-size door, it was not possible to fit the positive-pressure air-curtains which are generally adopted for this type of plant. In lieu of this arrangement, the rate of air flow when exhausting was increased above that normally applied.

Spent abrasive and sand is collected by means of a belt conveyor below the precipitator hopper, and taken by a motor-driven belt and bucket elevator to be discharged on to a jigging tray which feeds it to a magnetic drum. Here all non-magnetic material is discharged to waste, while the magnetized abrasive passes through a de-magnetizer and thence through a pneumatic cleaner, leaving cleaned abrasive only to return forward to the shot-blast unit (Fig. 3).

Shot-blast Unit

The shot-blast units for each room are of 30-in. dia. and suited to working pressures up to 100 lb. per sq. in. Each is provided with four heating strips, to minimize the possibility of condensation, and is also provided with a self-contained oil/water separator. The compressed air on entering the separating chamber makes contact with a series of metal baffles, of large cooling suface, which force the air to change direction rapidly before it enters the shot-blast unit proper. At the base of this separating chamber, a quick exhaust valve is opened every time the blast is shut down, so that any oil or moisture collected is automatically and frequently discharged. The abrasive-regulating valve at the base of the unit can be very readily removed for inspection, with negligible loss of abrasive from the unit.

Electro-pneumatic control of blasting is arranged, operating through a solenoid valve controlled by a switch on a low-voltage electrical supply. This switch can be mounted on the wall of the chamber or on the hose near to the nozzle.

Handling Arrangements

For taking the castings into rooms, four-wheel bogies, 6 ft. square are provided, having a load capacity of 10 tons. Lighting within each room

FIG. 3.—*Unit for recovery of sand and dust from used abrasive, and its return to the plant.*

FIG. 4.—*Base of the "Rotoclone" hydrostatic dust precipitator, showing the device for continuous dewatering and sludge removal.*

is by means of six 200-watt lights fitted on the roof and shielded by easily renewable glass-sheets. Safety clearances, accessibility and other requirements for efficient maintenance were carefully considered in the general design.

Dust Collection

The variable operating efficiency of dry collectors and the difficulties of their maintenance, together with the secondary dust problem which has always existed in the disposal of dry dust both within the works and at the tipping site, influenced the Edgar Allen management in favour of wet collectors for the new plant. Thus, two "Rotoclone" hydrostatic precipitators, type "N" (made by Air Control Installations, Limited), were installed, each connected to two shot-blast rooms. The capacity of the exhaust fans is sufficient to give eight air changes per minute in the rooms. The precipitators are of hopper-bottom design, with drag-type sludge ejectors for continuous automatic de-watering and removal of collected material (Fig. 4). Observations made over the past few months have shown that the high efficiency of dust separation is constantly maintained. An automatic water-level compensating feature maintains the efficiency over a wide range of exhaust volumes, with negligible change in pressure loss.

Air Supply

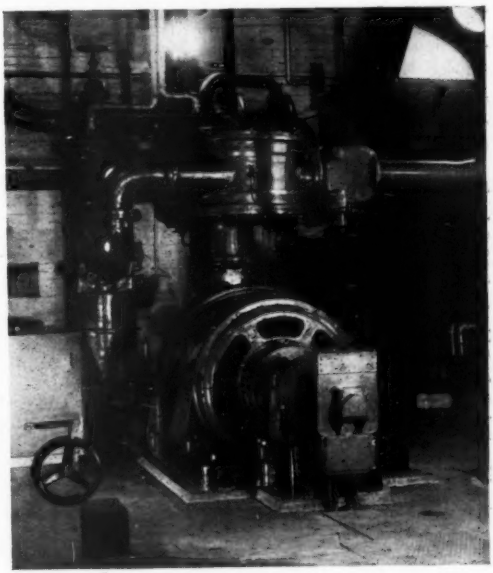
Compressed air requirements for all the new shot-blasting plant are met by two motor-driven air-compressor sets, each capable of delivering 1,005 cub. ft. of free air per minute at a delivery pressure of 105 lb. per sq. in. Each set consists of a Belliss & Morcom two-crank, two-stage M.9.S standard compressor unit driven direct by a 222 h.p. synchronous G.E.C. motor at 428 r.p.m. (Fig. 5). The air intakes to the compressors are fitted with "Visco" self-cleaning air filters of standard type, size 5/1, and of dimensions 3 ft. 10 in. wide by 6 ft. high, comprising a single section with five working filter cells and complete with a motorized mechanism for cleaning and changing the cells.

Cooling Water

Water for circulating through the compressors is cooled by a Heenan & Froude patent water-cooler, size 65. The cooler, which is suitable for use indoors, is capable of continuously cooling 3,960 gall. per hour from 93 to 78 deg. F. in summer conditions in this country.

Ample air-main and receiver capacity has been installed to permit simultaneous operation of all the shot-blast rooms under the heaviest load conditions. Although specifically installed to serve this plant, the compressed-air service is linked up with the works ring-main system, so that production will be maintained in case of major breakdown.

FIG. 5.—*One of the pair of Belliss & Morcom two-stage M.9.S. compressor units for supplying air to the new shot-blast rooms—delivering 1,005 cub. ft. per min. at a pressure of 105 lb. per sq. in.*



British Blast Furnaces in the March Quarter, 1957

(These tables are published through the courtesy of the British Iron and Steel Federation.)

Derbyshire, Leicestershire, Notts, Northants, and Essex.

Name of firm.	In blast at end of the first quarter, 1957.					Weekly average in blast.	Total existing at end of quarter
	Hematite.	Basic.	Foundry and forge.	Ferro-alloys.	Total.		
Clay Cross Co. (Iron & Foundries)	—	—	1	—	1	1	2
Ford Motor	—	—	1	—	1	1	1
Holwell Iron	—	2	1	—	3	3	4
Kettering Iron & Coal	—	—	2	—	2	2	2
New Cransley Iron & Steel	—	1	—	—	1	1	2
Renishaw Iron	—	—	2	—	2	2	2
Sheepbridge	—	—	—	—	—	1.9	2
Stanton Ironworks: Stanton-by-Dale	—	—	4	—	4	4.3	5
Staveley Iron & Chemical	—	—	3	—	3	3.9	4
Stewarts and Lloyds: Corby	—	4	—	—	4	4	4
Wellingboro' Iron	—	2	—	—	2	2	3
TOTAL	—	9	14	—	23	26.1	31

Lancashire (excl. N.-W. Coast), Denbighshire, Flintshire, and Cheshire.

Brymbo Steel	—	1	—	—	1	1	1
Darwen & Mostyn	—	—	—	1	1	1	2
Lancashire Steel Corporation	—	2	—	—	2	2.8	4
Summers, John	—	2	—	—	2	2	2
TOTAL	—	5	—	1	6	6.8	9

North-West Coast.

Barrow Ironworks	3	—	—	—	3	3	4
Charcoal Iron	—	—	1	—	1	1	1
Millom & Askam Hematite Iron	2	—	—	—	2	2	2
United Steel: Workington	2	—	—	—	2	2.6	3
TOTAL	7	—	1	—	8	8.6	10

Lincolnshire.

Appleby-Frodingham Steel	—	4	—	—	4	4	4
Lysaght's Scunthorpe Works	—	3	—	—	3	3	4
Thomas, R., & Baldwins: Redbourn	—	3	—	—	3	3	3
TOTAL	—	10	—	—	10	10	11

North-East Coast.

Consett Iron	—	3	—	—	3	3	3
Dorman Long (Steel): Acklam	—	2	—	—	2	2	4
Redcar	—	2	—	—	2	2	2
Bessemer	—	2	—	—	2	2	3
Clay Lane	—	2	—	—	2	1.2	2
Gjers Mills	2	—	—	—	2	2	5
Normanby Iron Works	2	—	—	—	2	2	3
Skinningrove Iron	—	2	—	—	2	1.3	3
South Durham Steel & Iron: West Hartlepool	—	2	—	—	2	2	2
Cargo Fleet	—	2	—	—	2	2	2
TOTAL	4	17	—	—	21	19.5	29

Scotland.

Bairds & Scottish Steel: Gartsherrie	1	1	1	—	3	2.5	5
Carron	—	—	1	—	1	1	4
Colvilles: Clyde Works	—	3	—	—	3	3	3
Dixon's Ironworks	—	2	—	—	2	2	6
TOTAL	1	6	2	—	9	8.5	18

South Wales and Monmouthshire.

Briton Ferry Works	1	—	—	—	1	1	1
Guest Keen Iron & Steel: Cardiff	1	2	—	—	3	3	4
Thomas, R., & Baldwins: Ebbw Vale	—	3	—	—	3	3	3
Steel Company of Wales: Margam	—	4	—	—	4	2.9	4
TOTAL	2	9	—	—	11	9.9	12

ICI Exports To US

Expenditure on the UK construction programme of Imperial Chemical Industries, Limited, in 1956, amounted to £44,000,000 and by subsidiaries, to over £12,000,000. The pace of development of manufacturing subsidiaries, chiefly overseas, is comparable with that at home. Since the end of 1945 ICI has expended £267,000,000 on new fixed assets and group fixed assets (ICI and its 97 subsidiaries) expanded to £375,400,000 (£341,600,000).

The export value of shipments of £73,100,000 represented just over a quarter of total sales and exports to the US increased by 16 per cent. to the record value of $5,750,000. European sales have been doubled since 1949 and records were broken in France, Holland, and Switzerland. External group sales of ICI of Australia and New Zealand reached the record level of £A36,700,000.

The group's employees' profit-sharing bonus amounted to £3,100,000 (£2,800,000) of which UK employees received an average of £27 4s. 3d. (£35 13s. 7d. gross). There are 16,777 employees with 25 or more shares and during the year £537,761 ICI ordinary stock was handed over to them.

Group sales rose by £24,300,000 to £435,300,000, but profit margins were reduced and trading profits contracted to £53,400,000 (£56,500,000). The 10 per cent. dividend is repeated.

Mr. ERIC SEGAR has been appointed area sales supervisor (supplies division) for the London region of Remington Rand, Limited.

Offer for Brush Group

Three reasons why the board of the Brush Group, Limited, recommends acceptance of the formal offer from the Hawker Siddeley Group, Limited, to acquire the capital of the group are given by the chairman, Mr. G. C. R. Eley. He points out that for some years the Brush Group has been hampered by a lack of permanent capital, restraining development through rationing expenditure on capital assets and research.

It could not fail to benefit from the pool of technical and manufacturing knowledge available in the Hawker Siddeley Group; and, thirdly, the commanding position held by Hawker Siddeley in the rapidly expanding Canadian economy seemed to be of especial interest. The offer is conditional upon 90 per cent. acceptance on or before June 7, and upon the Hawker Siddeley Group increasing its capital and borrowing powers. Thomas Tilling, Limited, holder of 20¼ per cent. of the ordinary, has accepted.

Of Hawker Siddeley's £30,000,000 authorized capital there is now £25,289,400 in issue. If offers to the Brush Group and to preference shareholders of the Armstrong Siddeley Development Company, Limited, become unconditional, the authorized capital will be £40,000,000 and the issued capital £31,021,400. The latter will comprise £5,060,000 in 5½ per cent. preference, and £25,961,400 in £1 ordinary.

AN OUTBREAK OF FIRE at the Dalton works of Dawson, Bentley & Company, Limited, ironfounders, Keighley, on May 24, damaged the roof of a one-storey building. The fire was quickly brought under control by Keighley Fire Brigade and production is understood to be little affected.

NEWTON CHAMBERS & COMPANY, LIMITED, Thorncliffe Works, Sheffield, are to contribute over half of the £18,500 cost of a sports pavilion and a football stand to be erected on the firm's recreation ground at Mortomley Lane. The remainder will be borne by the Thorncliffe Social and Recreational Association and the Football Club. The football stand is expected to be ready by September and the pavilion by next May. Of the £9,500 which is to be contributed by the company, £5,000 will come from a bequest made by the late Mrs Newton Drew to be used for the benefit of employees at the discretion of the directors. The remaining £4,500 will come from the company's funds.

British Blast Furnaces in the March Quarter, 1957—*continued*

Staffordshire, Shropshire, Worcestershire, and Warwickshire.

Name of firm.	In blast at end of the first quarter, 1957.					Weekly average in blast.	Total existing at end of quarter.
	Hematite.	Basic.	Foundry and forge.	Ferro-alloys.	Total.		
Goldendale Iron	—	—	1	—	1	1	2
Lilleshall	—	—	1	—	1	1	2
Round Oak Steel Works	—	—	—	—	—	—	2
Shelton Iron & Steel	—	3	—	—	3	3	3
Stewarts and Lloyds : Bilston	—	2	—	—	2	2	3
TOTAL	—	5	2	—	7	7	12
Sheffield.							
Park Gate Iron & Steel	—	2	—	—	2	2	2
GRAND TOTAL	14	63	19	1	97	98.4	134

Weekly Average Number of Furnaces in Blast during the March Quarter, 1957, and the Previous Four Quarters

District.	1956.				1957.
	March.	June.	Sept.	Dec.	March.
Derby, Leics., Notts., Northants and Essex	25.7	24.9	26.6	27	26.1
Lancs. (excl. N.-W. Coast), Denbigh, Flint, and Ches.	7	7	6.9	7	6.8
Lincolnshire	10.1	9.5	9.2	9.1	10
North-East Coast	21	21	20.2	19.8	19.5
Scotland	9	9	9	9	8.5
Staffs., Shrops., Worcs., and Warwicks	7	7	7	6.6	7
S. Wales and Monmouth	10.8	9.8	9.6	10.3	9.9
Sheffield	2	2	2	2	2
North-West Coast	9	9	9	8.2	8.4
TOTAL	101.6	99.2	99.5	99	98.4

The following companies have furnaces in course of construction or rebuilding:—South Durham Steel & Iron (Cargo Fleet); Millom & Askam Hematite Iron; Colvilles; Lancashire Steel Corporation; Steel Company of Wales.

M-V Turbine-generator Sets for Venezuela

An order, valued at nearly $3,000,000, has been received by the Metropolitan-Vickers Electrical Export Company, Limited. It covers two main turbine-generator sets, each rated at 66 mw., for installation in Arriaga No. 2 power station at Maracaibo, Venezuela. They will be supplied complete with all condensing, feed-water heating, de-aerating, and evaporating plant. The contract has been placed by the Montreal Engineering Company, Limited, on behalf of its associate, the International Power Company, Limited (of which C.A. Energia Electrica de Venezuela is a subsidiary). The whole of the plant will be manufactured at the M-V factories at Trafford Park, and Germiston, Glasgow.

The turbine-generator sets, which will run at 3,600 r.p.m., will have two-cylinder close-coupled turbines taking steam at 850 p.s.i.g. 900 deg. F. at the stop valve. The generators will be hydrogen cooled. The first of the new sets is due to be commissioned in October, 1960, and when both are installed Venezuela will possess one of the largest power stations in South America.

Mr. ALEXANDER SCOTT, works manager at the Carntyne Steel Castings Company, Limited, has been made a director. Mr. Scott is a member of the Institute of British Foundrymen.

Equipment & Supplies

Cupola Charger

Founders who are proposing to revise their cupola-charging arrangements will be interested in a Continental design of fully-automatic charging device, newly introduced to this country by Foundry Mechanisations (Baillot), Limited, of Denbigh Road, Bletchley, Bucks. The plant, marketed under the trade name of "Benoto," consists of charging buckets, hoisting mechanism and gantry framework, inclined jib and control features. Operational sequences, which commence by merely depressing a button, continue automatically through the full cycle of charging. Alternatively, they can be stopped at any point, and it is possible, afterwards, to continue the cycle, or to retrace to a former position. Fig. 1. shows a side elevation of the plant with the bucket in the unloading position.

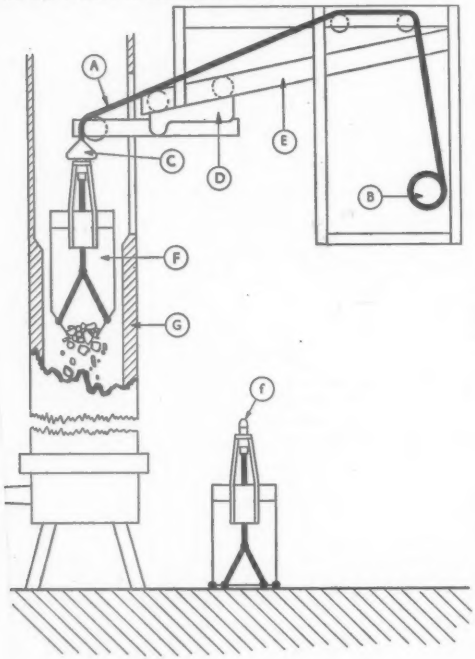


Fig. 1.—*Side elevation of a cupola and the automatic charging device marketed by Foundry Mechanisations (Baillot), Limited, shown in the charge-releasing position.*

(A) Hoist cable; (B) winch and motor; (C) hooking block; (D) charging carriage; (E) inclined jib; (F) bucket; ((f) filled bucket for next cycle of operations), and (G) cupola.

Operational Sequences

The following makes up a normal operational cycle:

(1). The motorized winch, activated by a starter, takes up the slack in the hoisting cable (A), and locks the bottom doors of the bucket; continuing, the winch then raises the bucket to a position above the charging door of the furnace.

(2). The bucket head then engages in the hooking block (C), and as this occurs current for the winch is reversed, the cable is wound, and the charging carriage (D) is released.

(3). As the winch unwinds, the charging carriage moves down the inclined jib (E) and reaches its extremity. Here the bucket (F) is unlocked, and continuing slackness of the cable releases the charge into the cupola (G). The reduction in load on the cable brings about another reversal of the winch.

(4). Slack in the cable is taken up, and the carriage moves up the gantry to its original position, closing and locking the doors beforehand.

(5). Once again the winch is reversed and the bucket is then lowered to floor level, preparatory to the next cycle.

The unit can be supplied for mounting upon rails for serving a series of cupolas in line, or pivoting to charge a number of furnaces ranged in an arc. A feature of the manufacturer's literature supplied to prospective purchasers is a comprehensive questionnaire which, when completed, enables the customers requirements to be easily catalogued for the purposes of estimation and design.

Oil Burners

A range of three oil burners, introduced by Prior Stokers, Limited, of York Way, London, N.7, embody a special flame-stabilization unit that has been developed in the company's laboratories. The burners are available with three capacities: 100,000 to 300,000 (model SH. 1); 300,000 to 500,000 (SH. 2) and 500,000 to 800,000 B.Th.U's per hr., (SH. 3) and are claimed to be fully automatic in operation. The automatic controls, which can be mounted on a wall panel, consist of a pressure control and surface or immersion thermostat. Ignition of the air/oil mixture is facilitated by means of a high-tension transformer.

Ignition Set

Founders who are troubled by ignition problems, with ovens or furnaces employing distillate fuels for heating, should note that Joseph Lucas, Limited, of Birmingham, have introduced a mains-operated ignition set (Model 4 B). The set consists of a step-up transformer, aluminium igniter box, associated high-tension cables, which are armour braided, and an igniter plug and porcelain insulator. When the set is switched on, the transformer supplies a high voltage to the igniter box; this is changed into a series of high-voltage pulses which pass through the igniter-plug gap in the form of intensive high-temperature sparks, at the rate of 4 sparks per second. The unit is claimed to be suitable for the direct ignition of light oils, such as diesel oil and kerosene, and for lighting a torch, which then can be used to ignite heavier fuel oils.

Tote Bin

For temporary storage, or to facilitate moving components, such as small castings, between departments, Precision Components (Barnet), Limited, Byng Road, Barnet, Herts, have introduced two tote bins. These are manufactured in Polythene, and as a result it is claimed that they are light in weight, strong, resilient and will withstand rough treatment, without causing damage to the components contained. The bins are available in two sizes, 13 by 7 by 3¼ in. (TB. 250) and 17 by 12 by 8 in. (TB. 300); they are available with swing-over handles and index-card holders.

News in Brief

THE LANCASHIRE DYNAMO GROUP sales office in Scotland moved to new premises on May 24. The address is 5, Woodside Place, Glasgow C.3 (telephone: Douglas 0867/9).

THE ECLIPSE WORKS of James Neill & Company, Limited, Napier Street, Sheffield, were toured by the Lord Mayor and Lady Mayoress of Sheffield, Alderman and Mrs. R. Neill, last week.

SEVEN SPECIAL TRAINS left Bradford for Blackpool on Saturday, May 18, taking over 3,500 employees, wives and friends on a day trip to celebrate the golden jubilee of the Bradford engineering firm of Hepworth & Grandage, Limited.

THE NEW SPANISH AGENT of Martonair, Limited, pneumatic equipment manufacturers, of Richmond (Surrey), is Industrial Alonso, Apartado 336, Gijón, which will represent the company in hoist business only. Martonair has opened an office at 28, Houston Street, Glasgow, C.3.

TWO NEW SUPER-TANKERS, each of 47,400 d.w. tons, have been ordered from Vickers-Armstrongs, Limited, by the Esso Petroleum Company, Limited. They will be completed in 1962 and 1963. A third vessel of similar size is to be built by Kockums at Malmö, Sweden, for delivery in 1961.

THE INDUSTRIAL TRUCK MANUFACTURERS' ASSOCIATION has recently been reconstituted and in future will be known as the British Industrial Truck Association. The address of the Association and the official secretariat is Peat, Marwick, Mitchell & Company, 94/98 Petty France, London, S.W.1.

THE Instruments, Electronics, and Automation Exhibition at Olympia, London, which closed on May 10, attracted an attendance of 53,084, including 2,690 buyers from 69 countries. Future exhibitions will be open to all nations in an attempt to make London the electronics and automation centre of the world.

AGRICULTURAL MACHINERY for Yugoslavia, valued at £2,500,000, ordered from Massey-Harris-Ferguson (Export), Limited, consists of 2,200 tractors, 12,500 implements and accessories, and 240 large self-propelled combine harvesters. The tractors will be fitted with diesel engines manufactured by F. Perkins, Limited, Peterborough.

A CONTRACT for the provision of slipway accommodation at Suva, Fiji, including the supply of slipway cradles and haulage gear capable of handling ships of up to approximately 1,000 tons, has been given to Head Wrightson Teesdale, Limited, a subsidiary of Head Wrightson & Company, Limited, by the Government of Fiji. The contract is valued at about £90,000.

THE 21ST ANNIVERSARY of the foundation of Air Control Installations, Limited, Ruislip (Middx), was celebrated last Thursday with an open day, when invited guests toured the factory. Employees and friends had their own celebrations on the following day, when a dinner and dance was held at Watford Town Hall. The company had its first offices above a small shop at Ruislip.

AT A CEREMONY held on Friday, May 17, a number of employees of the Silvertown Rubber Company, Limited, and its associated companies, the Palmer Tyre Limited, and Stepney Tyre & Rubber Company, Limited, were presented with long-service awards by the chairman of the company, Sir Eric Miéville. The 40 recipients of these awards together represented a total of over 1,200 years service.

THE CENTRAL ELECTRICITY AUTHORITY has awarded to the British Thomson-Houston Company, Limited, a contract, valued at nearly £1,000,000, for the design, manufacture, testing and installation of four 75,000-kw., 16,000-v. generator/motor units for the first major pumped-storage scheme in Great Britain and, it is believed, the largest of its kind in the world. This is at Blaenau Ffestiniog in North Wales.

AT A MEETING of the Midland Board for Industry on May 21, it was stated that unemployment in the Midlands had dropped back to its normal level below the national average. Latest figures place the regional percentage at 1.5 compared with a national 1.6, with the number of persons registered as unemployed falling from 37,708 to 31,776 between March and April. It was also reported that trade trends remained stable with a general slight upwards tendency.

Sir HAROLD SMITH, chairman of the Gas Council will open the £4,000,000 extension to the Litchurch Gasworks at Derby—which is at the centre of a new grid system for the distribution of gas to eight counties—on June 19. The extension has taken seven years to construct and makes the Litchurch gasworks the largest gas producing unit in the East Midlands. The gas produced there will be fed through a network of 550 miles of large-diameter pipes to Derbyshire, Nottinghamshire, Leicestershire, Northamptonshire, Staffordshire, Rutland, Buckinghamshire and Lincolnshire.

THE NATIONAL INDUSTRIAL FUEL EFFICIENCY SERVICE is now inviting enrolment for two refresher courses for works managers and plant engineers at Leeds and at Oxford in September. The Leeds course will be held at Leeds University from September 16 to 20, and will include the following subjects: "Problems of Works Management," "The Clean Air Act," "What Does the Works Manager Do?," "The Control of Steam Used for Process," "Instrumentation and Automation" and "The Private Generation of Power for Process Steam." There will also be evening film shows and a visit to a nearby-plant. The Oxford course will be held from September 23 to 27.

AS A 'THANK YOU" GESTURE for the co-operation and assistance given by the City of Birmingham to the Chamber of Commerce during the 31 years that the Chamber has been concerned with the British Industries Fair at Castle Bromwich, Mr. J. E. Belliss, president of the Chamber, on May 20 formally presented the Lord Mayor of Birmingham (Ald. E. W. Apps) with five hand-carved oak State banqueting chairs. Each is covered in green hide and fitted with the city shields. At the luncheon which preceded the presentation Mr. E. M. Clayson, chairman of the BIF executive committee, said: "Probably all of us here have seen the last of the BIF in its present form. Successful though the 1957 Fair has been, quite clearly the pattern must change for the future."

THE FIRST ROAD-FERRY-ROAD SERVICE to Spain began during the week-end (May 18-19,) when a special lorry left Leeds carrying a six-and-a-half ton heavy-duty lathe, made by Churchill-Redman, Limited, machine toolmakers, of Parkinson Lane, Halifax; it was on its way to the Barcelona Trade Fair. The lathe is being delivered by A One Transport, Limited, of Jack Lane, Leeds, and it is the first time the Spanish authorities have granted a licence for such a trip. Previously lorries were obliged to unload at the Spanish border and the goods had to be reloaded on to Spanish vehicles. It is reported that the road journey was decided upon when it was found that the cargo sailings to Spain were so irregular and unreliable that the

News in Brief

lathe might not have arrived in time for the Fair's opening on June 1.

IT IS ANNOUNCED THAT a series of lectures on "Management Through the Next Decade" are to be organized this summer by the London branch of the Institute of Industrial Administration. The talks which will form the sixteenth series of management lectures will be delivered in the Fyvie Hall of the Polytechnic, Regent Street, on Wednesday evenings at 6.30 p.m. from May 29 to June 26. The sessions will be open to the public at a fee of two guineas for the whole course, 10s. 6d. for individual lectures. The series will be followed on Wednesday evening, July 3, by the annual open meeting of the students' and graduates' section of the London branch. The meeting will commence at 7 p.m. in the Fyvie Hall, and Sir Geoffrey Vickers V.C. will be speaking on "Changing Concepts of Management."

THE EMPLOYEES of the old-established firm of the Bremner Machine Company, Limited, printers' engineers, Wharfedale Ironworks, Otley, which has gone into voluntary liquidation, have been informed by the managing director, Mr. R. A. Watkinson, a grandson of the founder, that the firm would continue running for some weeks to complete orders on the books but would ultimately close down, possibly in five or six weeks. A number of the engineers have already got jobs with other firms, some have been taken on by other Otley engineering works while others are having to go to firms outside the town. The Bremner company began nearly a century ago when a farmer, Richard Watkinson, went into engineering and began to make the newly-invented Wharfedale printing presses. The present company was formed in 1891.

A CONTRACT for shipyard development valued at well over £1,000,000 has recently been started by John Howard & Company, Limited, 13 Buckingham Gate, London, S.W.1, at Newport, Mon., for the Atlantic Shipbuilding Company, Limited. Design and construction of the entire project has been entrusted to John Howard, who have undertaken to complete all the work in 18 months. The main items in the project are: A new building dock, 755 by 110 by 25 ft. deep, with 100 ft. clear entrance, suitable for building 45,000-ton tankers; extensions to an existing building dock to provide a larger building berth suitable for 11,000-ton ships, and an extension to existing 90 ft. span production shop to an overall length of 800 ft. In addition, plate bending shops, stores buildings, steel stockyard, rail access and a large mould loft are in the course of construction.

Mr. J. Q. MCDONALD, president of the Caterpillar Tractor Company, Limited, of Illinois, USA, visited Scotland recently to inspect the company's Scottish factory at Tannochside, Lanarkshire. With him were Mr. W. J. McBrian, vice-president of the parent company, and chairman and managing director of the Caterpillar Tractor Company, Limited, and Mr. J. R. Munro, vice-president of the Caterpillar Foreign Trade Group and director of manufacturing foreign operations. The factory which is in an advanced stage of construction is expected to be ready for production of tractors next year. In Glasgow later, discussions were held with principals of firms which will act as the company's dealers throughout Britain. Three new managerial appointments were announced. Sales—Mr. D. F. Shinn; service—Mr. T. R. Wolforth; and advertising—Mr. C. G. Deakin. The managers will take over their new duties at the company's new offices in London.

Company News

ENGLISH ELECTRIC COMPANY, LIMITED—Underwriters of the £9,000,000 5½ per cent. stock, 1977-82 debenture issue have been required to take up about 55 per cent. of their commitments.

PULSOMETER ENGINEERING COMPANY, LIMITED—Mr. F. B. Duncan, the chairman, announces that following the acquisition of Skyhi, Limited, of Isleworth (Middx), the company is completing arrangements for the purchase of another important company.

HERBERT TERRY & SONS, LIMITED, spring and presswork manufacturers, etc., of Redditch (Worcs)—A final dividend of 15 per cent. makes 17½ per cent. for 1956, in comparison with 15 per cent. Profit after taxation was £141,153 (£140,887).

JOHN I. THORNYCROFT & COMPANY, LIMITED—The interim dividend is being reduced from 5 per cent. to 3½ per cent., less tax, on the £1,500,000 ordinary capital, in respect of the year to July 31, 1957. A final of 7½ per cent. made a total of 12½ per cent. for 1955-56, against a total of 15 per cent. for 1954-55.

THOS. FIRTH & JOHN BROWN, LIMITED—The company announces that approximately 99 per cent. of the rights issue to ordinary shareholders have been taken up. There were 9,000 application forms for additional shares totalling over 2,500,000 shares. It was therefore decided to resort to a ballot to be conducted by a notary public.

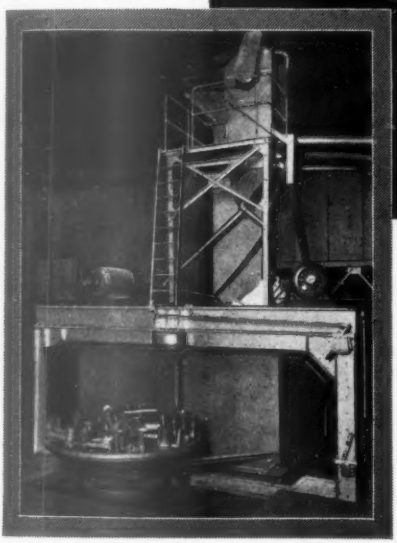
AIRSCREW COMPANY & JICWOOD, LIMITED, ventilation engineers, etc., of Weybridge (Surrey)—Arrangements have been completed whereby Bryant & May, Limited, will invest £500,000 in the company, subscribing for 2,300,000 ordinary 2s. shares at 3s. each, and making an unsecured loan of £155,000. After the issue, Bryant & May will hold about 41 per cent. of the ordinary capital.

G. & J. WEIR, LIMITED, engineers and founders, of Glasgow—The parent company's lower output and earnings, and higher costs, reduced the group trading profit in 1956 by £85,346 to £3,338,752. The group is engaged in designing valves for the oil industry and production on a large order towards the end of this year is anticipated. Active association with work for the UK Atomic Energy Authority continues. The total dividend is 30 per cent. (same) and CIC consent has been obtained for a 100 per cent. scrip issue.

ENFIELD ROLLING MILLS, LIMITED—Underwriting is being arranged for the issue by the company of 1,050,000 £1 ordinary shares at 30s. per share. A provisional allotment of 1,036,666 of the new shares is to be made to ordinary stockholders registered on May 15, in the proportion of one for every three ordinary units then held. Excess share applications will be invited. Of the net proceeds of the issue, approximately £500,000 is to be used for the provision of additional plant and extensions to buildings. The balance will be permanent working capital.

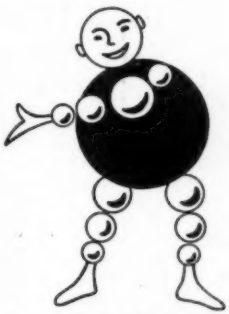
RANSOMES, SIMS & JEFFERIES, LIMITED—Turnover of the group of companies in 1956 fell by 15 per cent., and the directors report that they have been forced to announce selling price increases during 1957. The chairman, Sir Reuben Hunt, commenting on the general outlook, says that the further wage rise has made it more difficult to trade, especially overseas, and it appears that some oversea markets for agricultural machinery will be permanently lost. Group profit before tax was £219,368 (£418,202). The dividend is 6 per cent., equivalent to the 7½ per cent. paid for 1955 before the scrip issue.

TILGHMAN'S Dual Swing Table Wheelabrator Plant using Wheelabrator Steel Shot



The plant illustrated is a 6ft. Dual Swing Table Wheelabrator installed at Messrs. Jarrow Metal Industries Ltd. It is engaged in cleaning a miscellaneous load of steel castings and the cleaning cycle is eight minutes. This type of plant enables one table to be unloaded and reloaded whilst the other table is under the blast stream and each table is capable of carrying two tons.

LESS THAN FIVE TONS OF STEEL SHOT CONSUMED IN 6 MONTHS



This plant was installed in November, 1956 and in May, 1957 had not used all of the 5 tons of S.460 WHEELABRATOR Steel Shot delivered.
In the first few weeks of operation the machine was working three shifts per day in order to catch up on production, but is now employed on a 44-hour week only. During five weeks of the early period, 250 tons of steel castings were Wheelabrated and maintenance replacements in this time amounted to one set of blades and one deflector plate.

TILGHMAN'S LIMITED · BROADHEATH · ALTRINCHAM · CHESHIRE

A member of the Staveley Coal and Iron Co. Ltd. Group.
LONDON OFFICE: 1 Chester Street, S.W.1.

AGENTS: MIDLANDS.—R. J. Richardson & Sons Ltd., Commercial Street, Birmingham, 1.
SCOTLAND.—Balbardie Ltd., 227, Bath Street, Glasgow, C.2; 110, Hanover Street, Edinburgh 2.
NORTHERN IRELAND.—W. E. Stewart, 16, Sussex Place, Belfast.

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Personal

Mr. H. W. FULTON has resigned his directorship of Leyland Motors, Limited.

Mr. JOHN CAMERON, managing director of Cameron & Roberton, Limited, Kirkintilloch, has been appointed a Deputy Lieutenant of the County of Stirling.

Mr. J. T. HOLMAN has been appointed a director of the Climax Rock Drill and Engineering Works, Limited. Mr. J. H. CRAWFORD has resigned from the board.

Mr. G. E. COOPER has been appointed South Wales general manager of Dawnays, Limited, bridge and structural engineers, of London, S.W.11, in succession to the late Col. R. D. Heseltine.

Mr. J. R. V. DOLPHIN, who has been chief engineer to the weapons group of the United Kingdom atomic Energy Authority since 1951, has been appointed chief engineer to the authority's research group at Harwell. He will take up his new duties on August 1.

Mr. ROBERT A. BALFOUR, managing director of Arthur Balfour & Company, Limited, has been appointed chairman of the company. He succeeds LORD RIVERDALE OF SHEFFIELD, who has resigned as chairman and from the board. Mr. BERNARD HAYDN, senior, has been elected a director of the company.

Mr. M. H. HAMMILL, B.SC., A.M.I.MECH.E., who has been director and general manager of Foster Transformers, Limited, South Wimbledon, S.W.19, since 1950 has been appointed managing director. Before joining the Foster company—which is one of the Lancashire Dynamo Group—he was associated for many years with the industrial consultants, Urwick Orr & Partners.

Dr. A. G. E. ROBIETTE has resigned from the board of John Miles & Partners (London), Limited, but he will be retained by them in a technical advisory capacity. He is setting up as an independent metallurgical consultant and will be retained by metallurgical companies in this country, South Africa, and the United States. For the time being his address is Bury Farm, Bovingdon, Hertfordshire.

Dr. EDWARD GEORGE EDWARDS, principal of the Liverpool College of Technology, has been appointed principal of the Bradford Institute of Technology and takes up the post on September 1. He is 43, and a Fellow of the Royal Institute of Chemistry. The post was re-advertised because of the withdrawal on health grounds of Dr. J. F. J. Dippy, head of the department of Chemistry at Chelsea Polytechnic.

Mr. G. C. HEPWORTH, joint managing director of Hepworth & Grandage, Limited, engineers, Bradford, has been appointed chairman of the company, and his brother and co-joint manager, Mr. J. L. HEPWORTH, has been appointed a director of the parent company, Associated Engineering Holdings, Limited. Mr. T. BOOTH, general manager of Hepworth & Grandage (Yeadon), Limited, has been elected a director of that company.

A number of appointments within its sales force is announced by the Universal Asbestos Manufacturing Company, Limited, group. Mr. R. T. CHARLESWORTH becomes the representative for Devon and Cornwall with effect from June 3. Mr. F. M. GOMM has been appointed representative for various London districts from July 1, while Mr. W. TODD will be responsible for Middlesex, north-west London, and other London districts from the same date.

At the conclusion of 40 years' service with the Skefko Ball Bearing Company, Limited, Mr. GEORGE A. R. MEAD has indicated that he wishes to be relieved of all executive responsibilities with the company. He will, however, continue as an executive director of the company until March, 1959, and from that date will remain a member of the board. Mr. C. U. MAGNUSSON, who becomes sole managing director in September, joined Mr. Mead in July, 1954, when he succeeded the joint managing director, Mr. W. Siberg.

Sir RICHARD YEABSLEY, whose many business appointments include the chairmanship of Brown Bros. & Company, Limited, ferrous and non-ferrous metal stockholders, etc., of London, E.C.2, and a seat on the board of F. Perkins, Limited, diesel engine manufacturers, of Peterborough, has been re-elected president of the Society of Incorporated Accountants. The vice-president, who has also been re-elected, is Mr. EDWARD BALDRY, a member of the council of the London Chamber of Commerce. Mr. Baldry, who is associated with many companies, is a member of the London committee of National Bolts & Rivets, Limited.

Obituary

Mr. F. Cox died on May 14 at the age of 64. Mr. Cox was for many years commercial manager of Parker Foundry, Limited, Derby; he retired in 1949 owing to ill-health.

Mr. J. W. JONES, a member of the publicity department of the Mond Nickel Company, Limited, for 23 years, has died at the age of 53.

The death occurred on May 15 of Mr. T. MANBY at the age of 81. Mr. Manby was a director of Fred Manby & Bros., ironmongers and ironfounders, High Street, Skipton, a family concern dating back to 1817.

Mr. HARRY CANTRILL, whose death has occurred at the age of 66, was a former quality engineer at the Derby works of Rolls-Royce, Limited. He retired in 1954. During his career with the Derby firm he produced many famous engines including the Griffon, the Exe and the Eagle.

Mr. J. W. BECK, a director of John Brown & Company, Limited, Clydebank, and of the associated engineering undertaking, has died at the age of 65, having served with the company for 23 years. He was also a director of the North-West Rivet, Bolt & Nut Factory, Limited.

An outstanding figure in the foundry and engineering industry, Dr. NIELS EDWARD RAMBUSH, chairman and managing director of the Power-Gas Corporation, Limited, died on May 15 at the age of 68. Dr. Rambush was a native of Denmark and took a mechanical engineering degree at the Copenhagen Technical School. He was the patentee of many devices in chemical and gas engineering, and as long ago as 1931 he was awarded the Moulton Medal by the Institution of Chemical Engineers. More recently the University of Durham conferred upon him an honorary degree as Doctor of Science in recognition of his services to science and local industry. He was chairman and managing director of the associated company of Ashmore, Benson, Pease & Company, Limited, and a director of the International Meehanite Metal Company, Limited, Power-Gas Canada, Limited, Rose Downs & Thompson, Limited, and Rose Downs Holdings, Limited.

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REGD. TRADE MARK

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FOR SOFTENING AND REFINING CAST IRON

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Raw Material Markets

Iron and Steel

Maximum outputs of pig-iron are being obtained from the blast furnaces now in operation and the tonnages which are being produced, together with the additional quantity which will be obtained from fresh units to be blown in later in the year, should enable producers to attain their aim of a total output for the year of 14,000,000 tons. From this output the steelworks continue to absorb more than three quarters of the total tonnage. While present deliveries, together with the supplies which are being received from abroad, are generally sufficient for consumption requirements, larger tonnages will be required to meet the scheduled expansion in the output of steel ingots when increased melting capacity comes into operation.

So far as the ironfoundries are concerned, the expansion in production in the motor-car industry promises to result in a much bigger demand for castings. Many of the foundries catering for that trade are receiving increased orders and are calling for larger quantities of low- and medium-phosphorus pig-iron. Up to the present, the furnaces supplying these grades have been able to satisfy requirements from stock and production, but a continued increasing demand from these foundries, coupled with the requirements of other large users of these grades, may well result in a scarcity in supplies. Although for some months orders have fallen for the low- and medium-phosphorus irons, the furnaces have not been compelled to carry large stocks. Only a small overall increase in business would result in the demand being greater than the supply. Hematite makers are also benefiting from the improvement in business in the motor vehicle trade, and with the demands from other engineering and speciality foundries, together with the requirements of the steelworks, they are able to dispose readily of their outputs.

In the light-casting trade there are isolated cases of improvement in business, but for most of these foundries the position is not very bright. Orders being placed are readily completed and there is little forward buying. Most of the jobbing foundries are fairly busy, but the textile foundries have light order-books. The demands for high-phosphorus pig-iron are spasmodic and most producers of this grade find it necessary to place supplies into stock from current production. Tonnages are, in consequence, available for export, and when licences can be obtained export merchants are able to obtain business from the numerous inquiries which are being received.

The foundries are well provided with scrap, their main demand being for the better and heavier grades of cast-iron and machinery scrap. Light and medium scrap is plentiful. Foundry coke is coming to hand in sufficient quantities for present needs and demands for increased supplies are generally being satisfied.

The re-rollers maintain good outputs, and order-books are fairly full, although not so heavy as they were a short time ago. Stockists and consumers have fairly good stocks of small bars and light sections, and although regular business is being placed this is for smaller tonnages. There is a continued heavy demand for reinforcing rods, and the re-rollers of strip are receiving increased business from the motor-car trade. Most of the re-rollers are well provided with steel semis from the improved supplies from home steelworks, and many have received recently consignments from abroad which have brought their stocks for some sizes and grades up to full capacity. Chief demand is for small sized billets and special quality steels.

Non-ferrous Metals

Advice from New York at the end of last week suggest that an announcement from Washington is imminent concerning a blanket support programme for US basic mining and metal industries. Import restrictions on lead and zinc are widely expected, but opinion is divided over the possibility of effecting these import restrictions by the use of tariffs or quotas. By way of compensation for foreign producers having to meet import restrictions it is expected that selective bartering of agricultural surpluses for foreign produced metals will be resumed. It may be recalled that the US Tariff Commission in 1954 recommended higher duties, but this proposal was rejected on the grounds that higher duties would not solve the problems of the domestic industry. Instead, President Eisenhower introduced domestic stockpiling and foreign barter programmes were introduced. One way and another it would appear that the prices of lead and zinc are to be supported at their present levels.

Otherwise, the non-ferrous metal markets are featureless. Copper in London is still vulnerable at the present price and, although buying of forward metal on a relatively large scale has held up the price, it must be remembered that the market is now coming into the traditionally quiet holiday season. If, as seems likely, the US producers lower their price from its present 32 cents a pound, reduced prices in London would follow. At present, the producers' price is 2 cents above the custom smelters' quotation and 2¼ cents higher than the export price. It is, indeed, difficult to see how this rambling price structure can be maintained. The price of scrap is not very steady at 24½ cents a pound.

Tin is quiet both in London and in New York. In London stocks are at a satisfactory level, although the backwardation persists thereby suggesting that some of the stocks are held by the buffer stock. In the US the price is fluctuating around 98 cents a pound.

In lead, apart from the further ½ cent reduction in the US lead price on May 16, the market is nervously awaiting news concerning future stockpiling policy. Demand is steady in the US and good in London at the lower price levels.

Zinc is a cautious market in London, with consumers tending to purchase minimum requirements. The market, too, suffers from the lack of any clear news concerning future stockpiling activities of the US Government and of the future fate of barter transaction.

Vokes' Exhibition

Vokes, Limited, filtration and silencing engineers, of Guildford, Surrey, began the first of a five-day exhibition of their products at Kensington Palace Hotel, London, last Friday with an attendance of about 400 representatives of trade associations, customers, and members of the technical Press. Quite astounding was the range of products covered—from complete plants for processing tobacco to the manufacture of artificial limbs—but the section for which the group is perhaps best known, and that of major interest for readers of this JOURNAL was, of course, that devoted to compressed-air filters. An engineer of the firm reported that this equipment when installed in foundries is usually so trouble-free that it becomes forgotten, and it has taken special propaganda directed to maintenance men to remind users that filtering media do occasionally need changing.

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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

May 29, 1957

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £20 1s. 0d.; Birmingham, £19 13s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £21 18s. 0d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £22 2s. 3d.

Scotch Iron.—No. 3 foundry, £23 4s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £24 6s. 6d.; South Zone, £24 9s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £25 14s. 0d.; South Zone, £25 16s. 6d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £22 17s. 6d.; Scotland (Scotch iron), Zone S. 1, £23 4s. 0d.; Sheffield, £24 4s. 6d.; Birmingham, £24 12s. 0d.; Wales (Welsh iron), £22 17s. 6d.

Basic Pig-iron.—£19 3s. 0d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £50 0s. 0d. to £53 5s. 0d., scale 17s. 0d. to 17s. 6d. per unit; 75 per cent. Si, £70 0s. 0d. to £76 7s. 6d., scale 17s. 0d. to 17s. 6d. per unit.

Ferro-vanadium.—50/60 per cent., 28s. 6d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 12s. 3d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., 2-3 Cu, £250 0s. 0d.; 38/40 per cent., commercially carbon-free, £299 0s. 0d.

Ferro-tungsten.—80/85 per cent., 11s. 7d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 14s. 7d. per lb. of W.

Ferro-chrome (6-ton lots and over).—4/6 per cent. C, £96 0s. 0d. to £99 10s. 0d., basis 60 per cent. Cr, scale 33s. 0d. per unit; over 6 per cent. C, £94 0s. 0d., basis 60 per cent. Cr, scale 31s. 0d. to 33s. 0d. per unit; 2 per cent. C,* 2s. 2d. per lb. Cr.; 1 per cent. C,* 2s. 2½d. per lb. Cr; 0.15 per cent. C,* 2s. 3d. to 2s. 3½d. per lb. Cr; 0.10 per cent. C,* 2s. 3½d. to 2s. 3¾d. per lb. Cr; 0.06 per cent. C,* 2s. 3½d. to 2s. 4d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—90/92 per cent., carbon-free, £290 0s. 0d.; 96/98 per cent., £310 0s. 0d.

Ferro-columbium.—65/75 per cent., Nb + Ta, 22s. 0d. to 23s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £82 12s. 6d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £30 9s. 0d.; tested, 0.08 to 0.25 per cent. C, £31 9s. 0d.; hard (0.41 to 0.60 per cent. C), £32 10s. 6d.; silico-manganese, £41 0s. 0d.; free-cutting, £34 13s. 0d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £38 4s. 6d.; silico-manganese, £41 7s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £36 3s. 6d.; basic, hard, over 0.41 up to 0.60 per cent. C, £37 6s. 0d.; acid, up to 0.25 per cent. C, £40 7s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £39 2s. 0d.; boiler plates (N.-E. Coast), £41 12s. 0d.; floor plates (N.-E. Coast), £40 11s. 0d.; sectional material, N.-E. Coast, £37 11s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested (4-ton lots), £37 18s. 0d.; flats, 3 in. wide and under (4-ton lots), £37 18s. 0d.; hoop and strip, £37 17s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £41 6s. 0d.; black sheets (hand mill), 17/20 g., £52 4s. 6d.; galvanized corrugated sheets, 24 g., £65 9s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £65 10s. 3d.; nickel-chrome, £92 13s. 0d.; nickel-chrome-molybdenum, £104 11s. 6d.

NON-FERROUS METALS

Copper.—Cash, £235 0s. 0d. to £235 10s. 0d.; three months, £236 10s. 0d. to £236 15s. 0d.; settlement, £235 10s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 2s. 3⅞d. per lb.; rods, 269s. 6d. per cwt. basis; 20 s.w.g., 302s. 9d. per cwt.

Tin.—Cash, £763 0s. 0d. to £764 0s. 0d.; three months, £761 10s. 0d. to £762 0s. 0d.; settlement, £764 0s. 0d.

Lead (Refined Pig).—Second half May, £96 15s. 0d. to £97 0s. 0d.; second half August, £97 5s. 0d. to £97 10s. 0d.

Zinc.—Second half May, £81 15s. 0d. to £82 0s. 0d.; second half August, £79 5s. 0d. to £80 0s. 0d.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £116 15s. 0d.; rolled zinc (boiler plates), all English destinations, £114 10s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £99.

Brass Tubes, etc.—Solid-drawn tubes, 1s. 11⅛d. per lb.; rods, drawn, 2s. 11d.; sheets to 10 w.g., 200s. 9d. per cwt.; wire, 2s. 7¾d.; rolled metal, 201s. 3d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £169; B6 (85/15), £230; BS249, —.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £224; HTB2 (38 tons), —; HTB3 (48 tons), — .

Gunmetal.—BS1400, LG2 (85/5/5/5), £224; LG3 (86/7/5/2), £235; G1 (88/10/2/½), £286; (88/10/2/1), £276.

Phosphor Bronze.—BS1400, PB1 (AID released), £304 per ton.

Phosphor Bronze Strip, etc.—Strip, 291s. 0d. per cwt.; sheets to 10 w.g., 291s. 0d. per cwt.; wire, 3s. 11½d. per lb.; rods, 3s. 4d.; tubes, 3s. 4d.; chill cast bars: solids 3s. 3½d., cored 3s. 4½d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 10d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 2¾d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 1¾d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 5½d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £88 10s. 0d. Nickel, £600 0s. 0d. Aluminium ingots, £197 0s. 0d.; aluminium bronze (BS1400), AB1, £260; AB2, £286.

* Average 68-70 per cent.